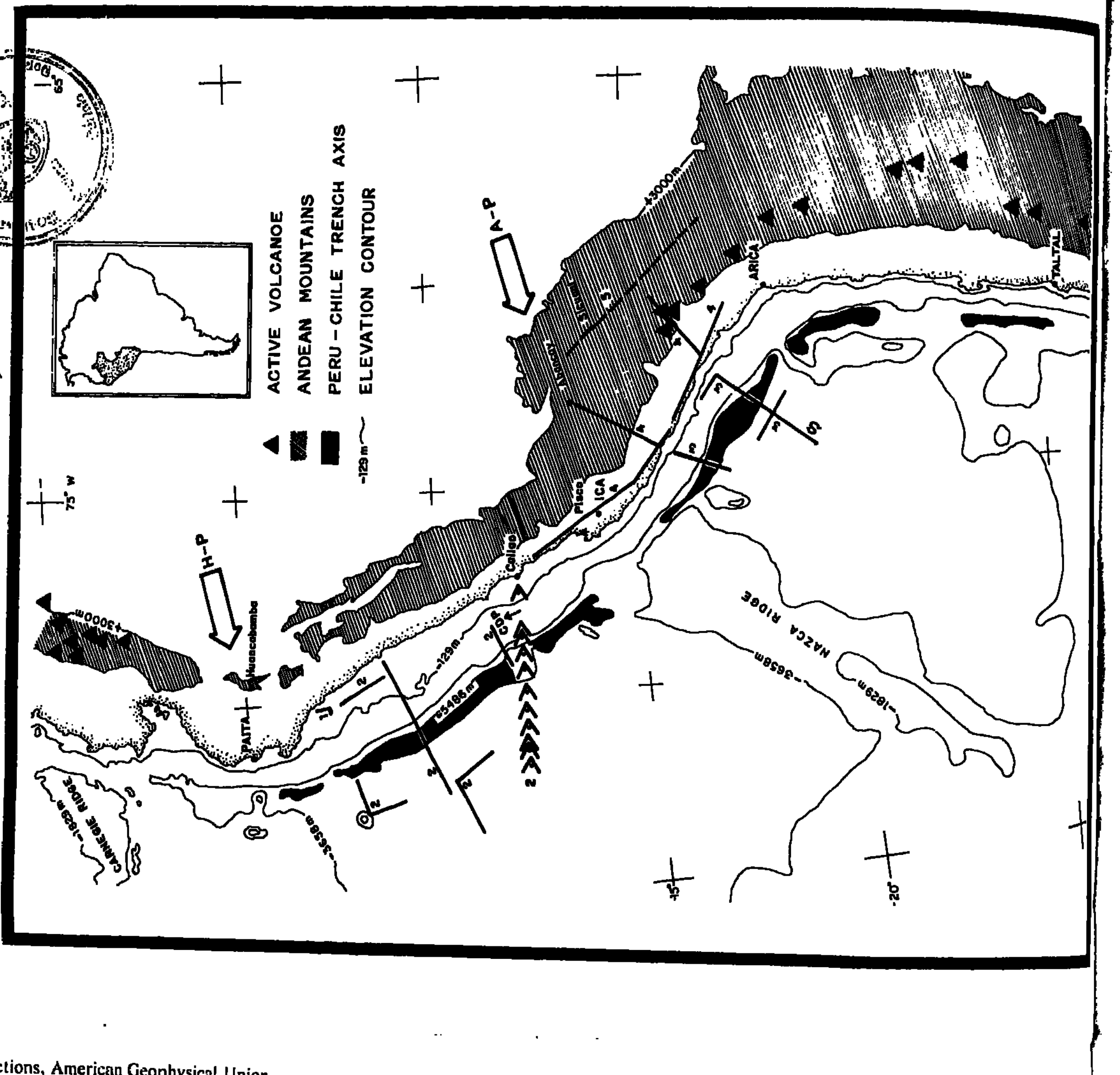
EOS
Transactions, American Geophysical Union
Vol. 64 No. 21 May 24, 1983



EOS, Transactions, American Geophysical Union Vol. 64, No. 21, Pages 385–392 May 24, 1983

GAP

Separates

To Order: The order number can be found at the end of each abstract; use all digits when ordering. Only papers with order numbers are available from AGU. **Cost:** $3.50 for the first article and $1.00 for each additional article in the same order. Payment must accompany order. Deposit accounts available.

Send your order to:
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

Hydrology

3150 Groundwater
A THEORETICAL EXPLANATION OF SOLUTE DISPERSION IN SATURATED POROUS MEDIA AT THE DARCY SCALE
R. S. Bhattacharya and Vijay L. Gupta (Dept. of Civil Eng., Univ. of Miss., University, MS 38677)

Geophysical Research Letters

Volume 10 Number 6 June 1983

MOVING?

Give AGU your new address!

Please allow up to 6 weeks for change to be effected. Only one notice needed for AGU membership record and all AGU subscriptions. Return this panel, with label, to:

American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

or call toll free 800-424-2488 or, in the Washington, D.C., area 462-6903.

Please print or type new address

New phone numbers (will be published in Membership Directory)
Office ( )
Home ( )

Francis W. Reichelderfer 1895–1983


NOAA

Francis W. Reichelderfer, who died January 26, 1983, introduced modern forecasting techniques to U.S. military and civilian weather prediction and spearheaded their dissemination throughout the world. When Reichelderfer retired as Chief of the U.S. Weather Bureau in 1963, Secretary of Commerce Luther H. Hodges declared that, "You are leaving a legacy of the world's largest and most sophisticated weather system. . . . During your tour of duty, your leadership and inspiration guided meteorologists throughout the world to work toward the common goal of a truly global weather system." President Kennedy and former Presidents Truman and Eisenhower sent letters of appreciation. In addition, Reichelderfer received gifts and messages from more than 50 other nations in recognition of his many contributions to the development of modern meteorology. Reichelderfer himself said that he had been fortunate "always to have been in the right place at the right time."

Reichelderfer was born in Harlan, Indiana, on August 6, 1895. In 1917 he graduated from Northwestern University, and in 1918 he joined the U.S. Naval Reserve Force to become a pilot. Sent to ground school at the Massachusetts Institute of Technology, Reichelderfer signed up for aerological (meteorological) training. Ensign Reichelderfer was sent to Nova Scotia, where he served as weather briefer for antisubmarine patrols until the Armistice.

In 1919 Jacob Bjerknes published *On the Structure of Moving Cyclones*, a monograph describing the revolutionary work of a group of Norwegian meteorologists whose theories and methods were to give Reichelderfer tools he would use to reshape American meteorological services. Vilhelm Bjerknes and his son Jacob had focused their attention on fronts and air masses (particularly the enormous outbreaks of cold air from the polar regions) rather than on individual storms, which represent only the interplay of air masses. Their work provided a logical, 3-dimensional atmospheric model that meteorologists could use to explain and forecast the weather.

Reichelderfer quickly grasped the importance of the Norwegians' work, wrote to Jacob Bjerknes, and began using the new methods himself. In 1922, now a lieutenant, Reichelderfer was sent to Washington, D.C., to direct the Navy's aerological service. During his Washington tour (1922–28) he revitalized the service and led it in the adoption of the Norwegians' meteorological methods. By 1925 he had made air-mass frontal analysis and forecasting techniques standard practice throughout the Navy.

On September 14, 1938, Willis Ray Gregg, Chief of the U.S. Weather Bureau, died at age 58. Because of Reichelderfer's achievements in modernizing the Navy's aerological services, he was picked to succeed Gregg. The first thing the new Chief did was to speed up and strengthen the changeover to air-mass analysis and forecasting. He reorganized the Bureau and began recruiting graduate meteorologists trained in the Norwegian methods. He also instituted intensive, inhouse training for Bureau personnel, particularly those in charge of weather analysis and forecast offices.

To improve public forecast and hurricane warning services, Reichelderfer had Bureau meteorologists prepare four public forecasts a day, rather than just two. A short time later (1939–1940), recorded telephone weather forecasts were introduced in New York City, Washington, D.C., Newark, Baltimore, Detroit, and Chicago.

In 1941, after the United States entered the World War II, President Roosevelt designated the Weather Bureau a war agency. Even before this, a Reichelderfer recommendation had led to the creation of a committee to coordinate civilian and military meteorological activities; the committee's functions soon were taken over by the Joint Meteorology Committee of the U.S. Joint Chiefs of Staff. Though now a civilian, Reichelderfer was made an official member of the committee.

Reichelderfer's membership on the Joint Meteorological Committee and successor groups was the key to the modernization and improvement of postwar Weather Bureau services. The wartime cooperation that developed during weekly and emergency meetings of civilian and military meteorologists would carry over long after the war ended and lead to rapid technological advances in American and global weather services. The postwar adaptation of World War II developments and the continuing revolution in technology reshaped meteorology. Reichelderfer sought out and, whenever possible, adapted each technological advance to improve Weather Bureau services.

Radar was one of the more significant meteorological applications to come out of World War II. Reichelderfer was among the first to see radar's potential value. In 1946, thanks to the wartime cooperation established between the Bureau and the military weather services, the Navy gave the Weather Bureau 25 surplus aircraft radar sets, which were subsequently modified for ground meteorological use. Further transfers followed, and the Bureau gradually established a network of weather surveillance radars to guard the tornado-prone midsection and the hurricane-vulnerable Atlantic and Gulf coasts of the United States. In the late 1950's the Weather Bureau developed its own advanced meteorological radar system, which also was adopted by the Naval Weather Service.

Like other meteorologists, Reichelderfer thought that mathematical analysis might provide the key to more accurate weather forecasts. His inquiries led him in 1944 to John von Neumann, who was working on advanced machine computation problems. In 1948, von Neumann established a meteorology group at Princeton University to explore the idea of mathematical weather predictions. The group, led by Jule Charney, modified mathematical equations developed earlier by Carl Gustaf Rossby and succeeded in producing numerical weather predictions. Von Neumann's new, internally programmed computer took only 5 minutes to make a 24-hour forecast. Machine weather forecasting became a practical possibility.

The development of such forecasts required the concerted effort of the Weather Bureau, Naval Weather Service, and the Air Weather Service, an effort Reichelderfer continually championed at meetings with his military colleagues. Each weather service subsequently provided a third of the money and manpower needed to establish a Joint Numerical Weather Prediction Unit in the Weather Bureau in 1954. A year later the unit acquired one of the first commercial, stored-program computers, and soon it was turning out forecasts twice a day. Within a few years, many other countries began making computer weather forecasts.

Soon after the National Aeronautics and Space Administration (NASA) was organized in August 1958 Reichelderfer went to its Administrator, T. Keith Glennan, to sell him on the idea of "a weather eye in the sky." Glennan could see both the value and the popularity of such a satellite, and he gave its development his strong support. TIROS I (Television Infra-Red Observation Satellite), the first experimental weather satellite, was launched by the United States on April 1, 1960. Five hours later, President Eisenhower was looking at a weather picture from space.

Even before TIROS I went blind, Reichelderfer was working hard to generate the political and financial support needed to develop the world's first weather satellite system. In August 1960, NASA and the Weather Bureau jointly invited meteorologists from 21 nations to participate in the analysis of weather data to be gathered by TIROS II. Routine international distribution of cloud analyses and storm advisories prepared from U.S. satellite photographs was arranged following the launch on November 23, 1960. One year later, NASA and the Bureau began training meteorologists from 27 countries to use satellite photographs in weather analysis and forecasting.

Reichelderfer, one of the key planners in the creation of the World Meteorological Organization (WMO), was elected its first president, serving from 1951 to 1955. The course he charted produced a smoothly functioning organization that has continued as the focus for successful international, regional, and global cooperative programs that address weather as a common concern of all countries. His efforts and those of Harry Wexler, chief Weather Bureau scientist, helped lay the foundation for the World Weather Watch and the Global Atmospheric Research Program, huge international programs whose possibility and success were based on the use of meteorological satellites.

Reichelderfer joined AGU in 1939. He was president of the Meteorology Section from 1944 to 1947 and served two terms as AGU vice president (1949–1953 and 1959–1960). Reichelderfer resigned from the Weather Bureau after serving it for 24 years and 10 months. Following his retirement, he served another decade as a consultant to the Weather Bureau, industry, and the World Meteorological Organization.

This tribute was written by Patrick Hughes *of the National Oceanic and Atmospheric Administration, Washington, DC 20233.*

News

Sea-Level Changes Investigated

The International Geological Correlation Program (IGCP) is launching a plan to identify and quantify the processes of sea-level change by producing detailed local histories that can be analysed and correlated for tectonic, climatic, tidal, and oceanographic fluctuations. The project, called IGCP-200, will be conducted through 1987. Its purpose is to provide a basis for predicting near-future changes for application to a variety of coastal problems, with particular reference to densely populated, low-lying coastal areas.

Sea-level variations are actually a complex of local, regional, and global processes. Sea-level data contain a wealth of information concerning internal and external effects and provide the only possibility for reconstructing paleogeoid surfaces and testing complex models. Project IGCP-200 intends to investigate these modulating factors and their interactions in an attempt to define the scales at which changes in sea-level occur, the associated effects on coastal and shelf deposit evolution, and to separate and quantify the causes of these changes (eustasy, isostasy, rheology, tectonics, climate, oceanic changes, astronomical effects, human influences, etc.).

Much of the research will focus on processes operating for periods ranging from a few years to a few thousand years. However, adequate prediction of sea-level change also requires lines of research concerned with the study of much longer time intervals within the Late Quaternary. The wide span of time scales is matched spatially; objects of study will range from single stations or profiles to the earth as a whole.

Three main lines of approach are being adopted:

(1) Collection, analysis, interpretation, and correlation of new and existing sea-level data, both from areas deficient in data and from key areas providing diagnostic evidence to evaluate assumptions underlying any models which may be developed.

(2) Survey and data analysis of coastal and shelf deposits to provide valuable information on resource exploitation, coastal land use planning, land subsidence, reclamation, aquaculture, and ecological studies.

(3) Analysis of tide-gauge records and the modeling of other short-term fluctuations, such as changes of the tidal range, storm surges, tsunami, etc., using computer simulation techniques carefully controlled by reliable, accurate sea-level data. Those wishing to take part in the activities of Project IGCP-200 may contact P. A. Pirazzoli, Laboratoire de Géomorphologie de l'E.P.H.E., 1 rue Maurice Arnoux, 92120 Montrouge, France.

Foreign Grants

The Smithsonian Foreign Currency Program, a national research grants program, offers opportunities for support of research in Burma, Guinea, India, and Pakistan in astrophysics and earth sciences; anthropology, archeology, and related disciplines; systematic and environmental biology; and museum programs.

Grants in the local currencies of the countries are awarded to U.S. institutions for research by senior scientists; collaborative programs involving host country institutions are welcome. Awards are determined on the basis of competitive scholarly review.

The annual deadline for applications is November 1. For additional information, contact the Foreign Currency Program, Office of Fellowships and Grants, Smithsonian Institution, Washington, DC 20560 (telephone: 202-287-3321).

U.S. Streams in March, April

March streamflow conditions were generally above average over most of the United States, and much of the eastern United State was awash in April, with record and near-record flows being set on streams from Maine to Louisiana, according to monthend checks on the nation's water-resource conditions by the U.S. Geological Survey (USGS). About 90% of the key index gaging stations nationwide reported average to above-average flow in April.

USGS hydrologists said [illegible] high streamflows [illegible] the Amite, Tan-gipahoa and Natalbany rivers and the Bogue Chitto in Louisiana and the Wolf and Biloxi rivers and Red Creek in Mississippi. The flow of the Amite River at Denham Springs, La., for example, peaked at about 59.7 million gallons (226 million liters) per minute on April 8, which is about 21% greater than the previous record high flow of 49.4 million gallons (187 million liters) per minute on April 23, 1977.

March Flows

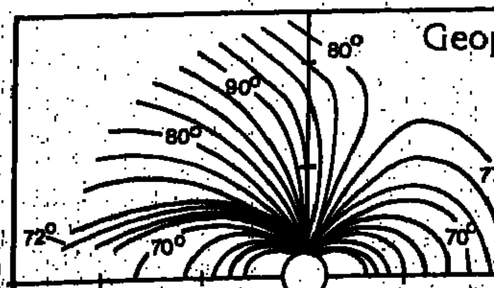
In contrast to most of the nation during March, streamflow conditions in the Ohio River valley were well-below average throughout Indiana, Ohio and Kentucky, and also in northern Tennessee, eastern Illinois, southern Michigan, western Pennsylvania and extending eastward into southwestern New York.

Dry weather continued to grip Hawaii in March. The island of Hawaii was designated as a drought disaster area. Streamflows at the four USGS index stations were in the below-normal range, with stations on the islands of Maui and Hawaii reporting new or record-equaling monthly or daily minimum flows.

The combined March flow of the nation's 'Big Five' rivers—Mississippi, St. Lawrence, Ohio, Missouri and Columbia rivers—averaged 962 billion gallons a day (bgd) (3.6×10^{12} liters per day—lpd), 1% below average for March. These large rivers account for streamflow runoff for more than half of the conterminous United States and their combined flow provides USGS hydrologists with a useful check on the status of the nation's water resources. Flow of the Ohio River at Louisville, Ky.—indicative of the dry conditions in the Ohio River valley—averaged 79 bgd (3×10^{11} lpd), 50% below the long-term March average and 10% below the February flow. Most of the key index gaging stations on streams feeding the Ohio River also reported below-average flows.

News (cont. on p.394)

Geophysical Monograph 21



ISBN 0-87590-021-6
List Price $30.00
30% discount to AGU members
• 550 pages •

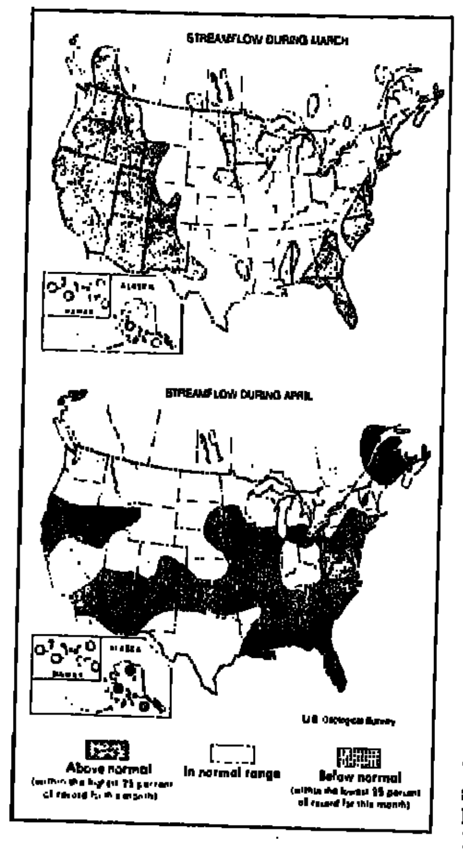
Quantitative Modeling of Magnetospheric Processes
edited by W. P. Olson (1979)

Providing an annotated list of quantitative models which serve as a reference on energy particle distribution and magnetic and electric models, this monograph was written in conjunction with the international Magnetospheric Study's activities.

Orders under $50.00 must be prepaid.

Published by:
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

News *(cont. from p. 393)*



The Big Five

Reflecting the reduced flow from its Ohio River tributary, flow of the Mississippi River at Vicksburg, Miss., averaged 478 bgd (1.8×10^{12} lpd), 9% below average for March; St. Lawrence River near Massena, N.Y., averaged 173 bgd (6.5×10^{11} lpd), 7% above average for this time of year; Columbia River at The Dalles, Ore., 154 bgd (5.8×10^{11} lpd), 94% above average for March; Ohio River at Louisville, Ky., 79 bgd (3×10^{11} lpd), 50% below average for March; and the Missouri River at Hermann, Mo., 77 bgd (2.9×10^{11} lpd), 61% above average for March.

April Flows

USGS hydrologists said that April was predominantly wet throughout the country, except for dry conditions along the U.S.-Canadian border from western New York through the northern part of the upper Great Lakes states and across parts of Montana, Idaho and Washington state. In the Ohio River valley, streamflow returned to the normal range after being well below average in March. During April, flow of the nation's Big Five rivers averaged 1,385 bgd (5.2×10^{12} lpd), 26% above the long-term average and 44% above the March flow.

The wettest part of the country in April was the area between Maine and Maryland where more than a dozen streamflow records for April were established, including new highs on the Mohawk River at Cohoes in New York and the Potomac River near Washington, D.C. To the south, from Virginia to Florida, 32 of the 37 key index gaging stations reported well-above average streamflows and 11 index stations reported the second or third highest flows ever recorded.

In Utah, the level in the Great Salt Lake continued to rise, increasing another 6 in. (15 cm) in April. The level at the end of the month was the highest in 58 years and more than 3 ft. (1 m) higher than the level at this time last year. Another hydrologic concern in Utah was the continuing growth of the young Lake Thistle—estimated size 12,000 acre feet (1.5×10^7 m^3)—created when a massive landslide formed a natural dam on the Spanish Fork River south of Salt Lake City.

Hawaii remained a dry spot in the United States. Streamflow conditions have been below average in the islands now for four consecutive months.

Streamflow in most of Alaska was well-above average during the month. A much below average snowpack for the winter of 1982–83 was reported by state officials.

The nation's groundwater resources rose seasonally during April and record high levels were set in key wells in Kentucky, Alabama and Virginia. In New York, new monthly high levels were recorded in five wells and two wells set new all-time high levels for the period of record. The level in the key index well near Rensselaer, N.Y., for example, stood at 8.38 ft. (2.5 m) below the land surface, about 2 ft. (0.6 m) above the long-term average and the highest level in this well in 28 years of record. The strong recharge and the record groundwater levels were especially welcome in wells in southeastern New York, where recent drought conditions had lowered water levels extensively.

The Big Five

Mississippi River near Vicksburg, Miss., 765 bgd (2.9×10^{12} lpd), 29% above average and 60% above the March flow; St. Lawrence River near Massena, N.Y., 178 bgd (6.7×10^{11} lpd), 4% above the seasonal average and 3% above last month's flow; Ohio River at Louisville, Ky., 147 bgd (5.6×10^{11} lpd), 9% above average and 86% above March; Missouri River at Hermann, Mo., 149 bgd (5.6 lpd), 161% above average and 95% above last month's flow; and the Columbia River at The Dalles, Ore., 146 bgd (5.5×10^{11} lpd), 2% above the seasonal average and 5% below March.

Geophysical Events

This is a summary of *SEAN Bulletin, 8(4),* April 30, 1983, a publication of the Smithsonian Institution. The complete Ulawun report is included; reports on Mount St. Helens and earthquakes are excerpted. The Asama report appeared in the May 10, 1983, *Eos.*

The complete bulletin is available in the microfiche edition of *Eos* as a microfiche supplement or as a paper reprint. Subscriptions to *SEAN Bulletin* are also available. For the microfiche, order document E83-005 at $2.50 from AGU Fulfillment, 2000 Florida Avenue, N.W., Washington, DC 20009. For reprints, order *SEAN Bulletin* (give volume and issue numbers and issue date) through AGU Separates; $3.50 for one copy of each issue number for those who do not have a deposit account; $2 for those who do; additional copies of each issue number are $1.00. For a subscription, order *SEAN Bulletin* from AGU Fulfillment. The price is $18.00 for 12 monthly issues mailed to a United States address; $28.00 (U.S.) if mailed elsewhere. Order must be prepaid.

Volcanic Events

Mt. St. Helens (Washington): Intrusive and extrusive dome growth continue.
Etna (Sicily): Lava effusion continues; central crater explosions; deformation, temperature, and self-potential data.
Kilauea (Hawaii): Lava effusion stops; low level harmonic tremor, local incandescence, and extension continue.
El Chichón (México): Crater lake recedes rapidly; stratospheric aerosols reduce solar radiation; high latitude aerosols sampled.
Colima (México): Vapor emission from fumarole field; SO_2 flux estimated.
Paricutín (México): Fumaroles emit acid gases.
Nicaragua: Activity at six volcanoes summarized; ash eruption at Concepción; temperature increase and tremor at Momotombo.
Costa Rica: Activity at three volcanoes summarized.
Macdonald (S-central Pacific): Eighth known eruptive episode detected.
Pumice Raft (Kermadec Is.): Floating pumice 460 km WNW of Raoul Island.
Asama (Japan): Summit crater explosive eruption.
Iwo-Jima (Volcano Islands): Earthquake swarm, two weak steam explosions.
Kusatsu-Shirane (Japan): Small phreatic explosion; harmonic tremor.
Niigata-Yake-Yama (Japan): Fresh ash on snow.
Sakurajima (Japan): Explosion rate, seismicity decline; lapilli ejected.
Ulawun (New Britain): Increased seismicity, including volcanic tremor.
Manam (Bismarck Sea): Vapor emissions, detonations, glow, ashfalls.
Langila (New Britain): Six explosions, highest cloud to 8 km.
Ruapehu (New Zealand): Crater lake green; low pH of river water.
White Island (New Zealand): Deflation ends.

Mt. St. Helens Volcano, Cascade Range, Washington, USA (46.20°N, 122.18°W). All times are local (UT − 8 h through April 23; UT − 7 h thereafter). Since early February, when explosive activity on the upper E flank was followed by extrusion of a new lobe (see *SEAN Bulletin 8* (1–2)), growth of the composite lava dome has been essentially continuous. Accelerating outward movement of the dome had preceded previous extrusion episodes, but stopped as lava reached the surface. However, substantial endogenous growth has continued throughout the current episode. Poor weather continued to hamper observations.

About April 1, a broad, stubby spine began to emerge at roughly 1 m/day from the center of the February lobe, reaching 30 m in N-S dimension, 20 m E-W, and about 25 m in height. Growth of this spine stopped about April 15 and extrusion of another spine started about 70 m to the SE. The latter spine remained active until about April 27, when at 60 m height it was the highest point on the dome and roughly the same size as the now-toppled February spine (see *SEAN Bulletin 8* (2)). Between visits to the crater April 29 and May 4 a new lobe began to grow high on the NE flank of the February lobe. This lava had a typical 'spreading center' source and scoriaceous carapace. Extrusion continued as of May 11 but the growth rate was slow and it remained several times smaller than previous lobes.

Dramatic deformation has continued on the E and particularly the NE sector of the dome since early to mid March. Because of frequent rockfalls, it was difficult to maintain targets on these areas of the dome, but rates of deformation reached 1.5 m/day and averaged about 1 m/day over roughly 1-week periods. Between measurements May 4 and 11 the NE margin of the dome moved 9 m outward and 2.5 m downward. Deformation on the N side of the dome was limited, but significant rate changes were observed. Through March the rate was constant at about 1.5 cm/day, but dropped to about 1 cm/day around April 1 as spine growth started. Deformation slowed further to 7–8 mm/day around April 15 as growth of one spine stopped and extrusion of another began (see above) but returned to about 1 cm/day at the end of the month and remained at that rate as of May 11. The W side of the dome, site of the most rapid deformation before many previous extrusion episodes, remained quite stable. No significant deformation of the edifice as a whole was detected.

Vapor and tephra emissions continued from the main vent near the source area of the February lobe but were relatively infrequent, occurring 1–3 times per day. Blocks up to 30 cm in diameter were ejected. Tephra could often be seen in the plumes, which sometimes rose to 1 km above the crater rim; the largest, April 18 at 1259, reached 6 km altitude. There was no apparent correlation between plume emissions and changes in extrusive activity or deformation.

SO_2 emission remained at roughly 150 tons per day until about April 27, when it dropped to 60–90 tons per day. A similar rate was measured April 30 and May 4, but SO_2 emission returned to 150 tons per day May 11.

Seismic activity remained elevated through April. Almost all were of low frequency with emergent onsets, a similar pattern to that seen in March. Between April 1 and 12 daily earthquake totals commonly ranged from 4 to 8, increased to 8–12 events per day April 13–24, then dropped slightly to an average of 8 per day through the end of the month. Surface and avalanche events showed a similar pattern. About April 20, sequences of tiny, discrete, similar events, previously seen in February (see *SEAN Bulletin 8* (2)), reappeared on one seismometer, but these events could not be located and their significance remained uncertain. The start of extrusion of a new lobe of lava between visits to the crater April 29 and May 4 (see above) was not marked by an obvious change in seismicity. Geologists working in the crater May 11 heard loud but relatively small earthquakes, which had not been audible during previous extrusion episodes.

Information Contacts: Donald Swanson and Tom Casadevall, USGS Cascades Volcano Observatory, 5400 MacArthur Blvd., Vancouver, WA 98661, USA; Steven Malone, Geophysics Program, University of Washington, Seattle, WA 98195, USA.

Ulawun Volcano, New Britain Island, Papua New Guinea (5.04°S, 151.34°E). All times are local (UT + 10). This report is from P. Lowenstein.

'Increasing seismicity, possibly indicating an eruption in the near future, continued at Ulawun in April and included periods of volcanic tremor. Amplitudes of discrete events were generally low, although a degree of cyclicity in amplitudes was apparent, with a period of about 8–11 days. Daily earthquake totals increased from about 600 to about 1500.

'After the March 21–23 seismic crisis (see last month's *Bulletin*), Ulawun's seismicity showed a fairly steady decay, reaching a very low level in early April. One clear A-type event was recorded on April 7. A new seismic crisis, preceded by a lull about 2 h long, began on April 10 at about 0310. The initial, strong continuous tremor changed to discontinuous tremor within a few hours. The entire period of tremor lasted about 6 h. After this crisis, a steady decline was evident until April 17. Small A-type events were recorded April 11–16.

'On April 17, 5 periods of tremor occurred. After about 3 h of very low seismicity, the first began at 1615. A distinct lull also preceded the third period. Tremor was mostly continuous, with total duration of about 280 minutes. Individual periods lasted about 20–106 minutes and were followed by about 5 h of frequent, discrete shocks and discontinuous tremor. Beginning April 18 a gradual decay in amplitude and frequency of occurrence of the shocks was recorded. Possible small A-type events were recorded April 20–29.

'No unusual visible activity directly accompanied the seismic crisis. However, ejection of one or more "smoke rings," seen to rise rapidly to about 500 m above the summit, was reported April 11–18. Blue vapour emission was seen April 14. Ulawun's usual white vapour emissions were moderate to strong throughout the month, but increased toward the end.'

Information Contact: P. Lowenstein, Senior Government Volcanologist, Rabaul Volcano Observatory, P.O. Box 386, Rabaul, Papua New Guinea.

Meteoritic Events

Fireballs: Kenya; Alaska, central, Illinois, Oregon, USA; central USA

Earthquakes

Information Contacts: National Earthquake Information Service, U.S. Geological Survey, Stop 967, Denver Federal Center, Box 25046, Denver, Colorado 80225 USA.

Date	Time (UT)	Magnitude	Latitude	Longitude	Depth of Focus	Region
April 3	0250	$7.2M_s$	8.73°N	83.12°W	shallow	SW Costa Rica
April 4	0252	$6.5M_s$	5.73°N	94.81°E	85 km	Off N Sumatra
April 5	0651	$5.6M_s$	40.06°N	75.29°E	shallow	S Kirgiz SSR
April 12	1208	$6.5m_b$	4.89°S	78.18°W	107 km	NW Peru
April 18	1059	$6.7m_b$	27.86°N	62.20°E	89 km	SE Iran
April 22	0038	$6.0M_s$	14.98°N	99.05°E	10 km	W Thailand

ISBN 0-87590-250-2
Coastal Upwelling
Francis A. Richards, editor (1981)
Coastal Upwelling, the first volume in AGU's newest book series, explores, studies, and reports on a vital part of our ecosystem through a multidisciplinary perspective.
Substantial progress has been made in identifying causal relations between physical and biological fields and processes. This progress aids in setting up consistent physical and biological data sets and models of the coastal upwelling system.
Topics include the environmental forcing functions and the physical, chemical, and biological aspects of the upwelling ecosystem.
Papers are, in part, derived from the IDOE International Symposium on Coastal Upwelling. Articles are also based on the expedition results of the Coastal Upwelling Ecosystems Analysis Program and similar research groups.
• 544 pages • Illustrated • price $29.00
American Geophysical Union
2000 Florida Ave., N.W.
Washington, D.C. 20009
Call 800-424-2488 toll free
462-6903 in the Washington, D.C. area
Orders under $50 must be prepaid.
30% member discount
Standing orders are welcome.

Books

The Road to Jaramillo

W. Glen, Stanford University Press, Stanford, Calif., xvii + 459 pp., 1982, $37.50.

Reviewed by Henry Frankel

William Glen has written a highly detailed account of the overall development of the time scale for geomagnetic reversals based upon the potassium-argon dating of young volcanic rocks. His treatment begins with an account of the methods developed at Berkeley during the 1950s by John Reynolds, Garniss Curtis, and Jack Evernden for dating geologically young rocks. Then he details the use of these methods by Allan Cox, Richard Doell, and Brent Dalrymple at the U.S. Geological Survey in Menlo Park, Calif., and Ian McDougall and Don H. Tarling at the Australian National University (ANU) in Canberra to date magnetic rocks. And finally he covers the use of the resultant time scale in the confirmation of the Vine-Matthews-Morley hypothesis.

The amount of detail provided by Glen is immense. His source materials include most of the relevant publications plus research proposals, various letters of correspondence among major participants, and an impressive number of interviews, many of which are presently housed in the Bancroft Library at the University of California, Berkeley. This book should be of interest to practicing physicists as well as historians and philosophers of science. Because it is extremely rich in scientific detail, I recommend this book to those interested in the overall revolution in the earth sciences. However, I have several reservations about the book and several serious disagreements with Glen's analysis. I will take up my disagreements after describing the scope of the book.

The basic text is divided into three parts. Glen first covers Reynolds' construction of a static-mode mass spectrometer for the [illegible] cation principally by Curtis and [illegible] dating young rocks. The second section, the largest and most important in the book, details the development of increasingly more accurate time scales. Glen begins by considering, but rejecting as historically insignificant, Martin Rutten's 1959 geopolarity reversal time scale. He offers a highly detailed account of the development of the time scale by Cox, Doell, and Dalrymple, but gives a less complete explication of the time scale's development by their competitors at ANU—Glen considers only the two early time scales of the Australian group. His presentation of the numerous time scales developed by the Menlo Park group is very good, for he discusses some of the incorrect assumptions and empirical mistakes which plagued the group on its road to the Jaramillo. In addition, through his various interviews he brings to life much of the controversy the group faced in its attempt to begin the project.

The third section of the book deals with the application of the time scale to the Eltanin-19 profile and the Juan de Fuca and Reykjanes ridges. Glen also traces the development of the Vine-Matthews-Morley hypothesis by Vine, and considers Lawrence W. Morley's independent presentation of the hypothesis. He argues, quite correctly, that the hypothesis should be referred to as the Vine-Matthews-Morley hypothesis rather than simply as the Vine-Matthews hypothesis. Glen considers the development of the reversal time scale by Neil Opdyke and his students at the Lamont-Doherty Geological Observatory along with a fairly detailed account of the reception and eventual acceptance of the hypothesis by those at Lamont-Doherty.

In the epilogue he summarizes the overall history and ends with several appendices, including a brief account of some of J. Tuzo Wilson's various contributions to the revolution. (See *Laudan* [1980] for a broader treatment).

Detail vs. Synthesis

My general reservation about the book pertains to the relative amounts of historical detail compared to the methodological and historical insight Glen adds to his narrative. *The Road to Jaramillo* is very dense with regard to specific factual information but relatively light on synthesis. This makes it somewhat difficult for the reader to discern what occurred, and I believe that the book would have been improved if Glen had drawn out some of the methodological import of his case study. Glen discusses administrative and social entanglements, but his accounts are too brief to describe precisely what occurred.

Restricting my attention to the development and application of the radiometric polarity reversal time scale, I have three specific objections to Glen's account. The first concerns Glen's major thesis about the importance of the time scale in the overall revolution and confirmation of sea floor spreading and the Vine-Matthews-Morley hypothesis (hereafter VMM). The second pertains to his discussion of the contributions to the time scale by those connected with ANU. The third deals with his assessment of Martin Rutten and his time scale. (See *Frankel*, [1982] for a somewhat different account of the development, reception, and eventual acceptance of the Vine-Matthews-Morley hypothesis.)

Glen's major historical thesis, although never stated, takes several forms; in its most grandiose form, it is that the discovery of the Jaramillo and subsequent reversal time scale was the key to the revolution (p. 2). Surely, this cannot be Glen's view of the matter. The major keys to the revolution were conceptual: Harry Hess's idea of sea floor spreading and its two major theoretical corollaries (namely, VMM and Wilson's idea of transform faults) and the transformation of Wilson's idea to a sphere with the development of plate tectonics by W. J. Morgan and D. P. McKenzie and R. L. Parker. Elsewhere (p. 139), Glen states that the "Jaramillo" time scale was the master key in confirming VMM and sea floor spreading. This again is overstatement; the confirmation of sea floor spreading depended upon the confirmation both of VMM and Wilson's idea of transform faults, while confirmation of Wilson's idea was independent of the Jaramillo time scale.

Perhaps Glen's thesis is that the correct radiometric reversal time scale was the key to confirming VMM. However, this also is incorrect. The discovery of the Jaramillo by Cox, Doell, and Dalrymple allowed for determination of constant sea floor spreading rates. When Vine and Wilson initially attempted to determine the spreading rate for the Juan de Fuca ridge based upon the Mason and Raff profile of the ridge, they ended up with an uneven spreading rate. Indeed, this was a problem, and Vine wasn't fully convinced of his hypothesis until Brent Dalrymple told him of the discovery of the Jaramillo in November 1965 at the annual GSA meeting in Kansas City.

But, the master key wasn't the correct radiometric time scale; it was the profile showing the symmetrical pattern of magnetic anomalies around the ridge axis. When one turns to Lamont-Doherty, again it is the profile—Eltanin-19— which provided the master key. Indeed, Opdyke and Pitman didn't even know about the discovery of the Jaramillo before they were pretty well convinced of the fundamental correctness of VMM. Moreover, they didn't need the Jaramillo, discovered through an analysis of deep-sea cores.

This point may be made in a slightly different fashion. Glen speaks of the serendipitous use of the time scale (after Cox) and says that "no one dreamed of what was about to unfold" after discovery of the Jaramillo (p. 266). But this is false. Vine knew what would unfold, and immediately unfolded a constant spreading rate. Opdyke, upon seeing Eltanin-19, knew what a correct time scale would yield, and he and his graduate students got busy on the sediment cores. Imagine if Morley, Wilson, Hess, Carey, and many of the directional paleomagnetists (such as Irving, Runcorn, or Creer) had been told of the Jaramillo. They too would have known what the discovery meant. Of course, when Cox, Doell, and Dalrymple began their research, they had no reason to know what would unfold. But things were different in the spring of 1965. There was VMM and Vine and Wilson's initial analysis of the Juan de Fuca with a non-uniform spreading rate.

Glen's overall thesis makes it appear as if his book covers the major events leading to the revolution. But in reality, his book primarily covers just one aspect of the revolution—the race to compile a sufficiently complete and reliable data base to construct the reversal time scale.

Sighting ANU

Glen's discussion of the contributions made by the group connected with ANU is [illegible] incomplete. [illegible] only their two early time [illegible] given an inaccurate picture of just how close the ANU group was to discovering the Jaramillo. There is no question that the Menlo Park group rightfully deserves the credit they have received for discovering the Jaramillo and providing Vine with a basically correct time scale. That they were the first to put the boundary between the Brunhes and the Matuyama epochs at 0.7 million years and designate the next polarity change as the event named the Jaramillo at around 0.9 million years within the Matuyama are well known. But, what is not so well known is just how close the ANU group was to Jaramillo. Because *The Road to Jaramillo* is supposed to be a detailed account of the development of the radiometric time scale, this later work of the ANU group should have been included.

The ANU group published three pertinent articles offering two new time scales; these articles were originally submitted for publication prior to their knowing about the discovery of the Jaramillo event, although none were published until after the Doell and Dalrymple paper on the Jaramillo [*Doell and Dalrymple*, 1966]. In the third paper, they proposed the existence of the Gilsa event, an additional event in the Matuyama [*McDougall and Wensink*, 1966]. It was received by *Earth and Planetary Science Letters* about a month after the publication of the Doell and Dalrymple article. The second paper, which discusses their recent work in Victoria, was received by the *Journal of Geophysical Research* on March 24, about 2 months before the publication of Doell and Dalrymple's article [*McDougall, Allsopp, and Chamalaun*, 1966].

The first paper contains the first published version of their third time scale and discusses their recent finds from Réunion with reference to the results from Victoria [*Chamalaun and McDougall*, 1966]. Unfortunately, there is no published date of reception and it would be of some historic interest to know that date. According to McDougall, the Réunion work was done in 1964 (Glen, p. 218). The Doell and Dalrymple article was received by *Science* on February 2, 1966, although Dalrymple discussed the possible discovery of the Jaramillo in November 1965 at the GSA meeting (Glen, p. 262). I don't know whether the ANU group had submitted its third time scale before the Menlo Park group presented its time scale containing the Jaramillo. But it doesn't really matter. What is important is that the ANU group constructed its third time scale quite independently of the Jaramillo discovery, and that this time scale was almost correct.

The ANU group reported results from three groups of lavas from Réunion. The six samples from the first group ranging in age from 0.43 to 0.58 million years had normal polarity. These results were important for further establishing normal polarity up to 0.71 million years—the corrected date for the Bishop Tuff. The third group provided additional support for the Olduvai event. However, it is the second group of lavas which generated the most excitement. Five of the specimens, ranging in age from 1.07 to 1.18 million years, had reversed polarity. But three of the samples, located on the road to Takamada, dated at 1.01 million years, had normal polarity. Their discussion of the results contained the following:

> These data suggest that either the boundary between Brunhes normal and Matuyama reversed epochs occurred at 0.75 ± 0.07 m.y., with a short interval of normal polarity (that is, an event) at close to 1.01 ± 0.03 m.y. and the reversed polarity of rocks dated at 0.81 m.y. [data from Victoria and France collected by the ANU group and discussed in their next article] records an event in an otherwise normal epoch. Another possibility is that self-reversal is partly responsible for the somewhat confused picture. Clearly many additional data are needed in the age range 0.7—0.1 m.y. to distinguish between the alternative explanations [*Chamalaun and McDougall*, 1966, p. 1214].

This passage warrants comparison with the corresponding section of *Doell and Dalrymple* [1966].

> The placement of the Brunhes-Matuyama boundary is more or less arbitrary in view of the present data. It could be placed between 0.9 m.y. and 1.0 million years ago, in which case the three reversely magnetized domes with ages between 0.71 and 0.73 million years would represent a reversed polarity event in the Brunhes normal epoch; or the boundary could be placed at 0.7 million years ago with 4D057 and 3X187 representing a normal event in the Matuyama reversed epoch at about 0.9 million years. For purposes of stratigraphic correlation, the last transition of polarity will undoubtedly be the most useful, and we therefore prefer to assign the epoch boundary at 0.7 million years. Accordingly we here name the "Jaramillo normal event" . . . From the present data it is not possible to tell whether the intermediate direction represents the transition to or from the Jaramillo normal event, nor, therefore, whether the event occurred just before or just after 0.9 million years ago [*Doell and Dalrymple*, p. 1061].

Both groups realized they had discovered a new polarity reversal which had occurred around 1 million years ago in addition to the reversal of 0.7 million years. Both groups realized that they could designate the more recent change as the Brunhes-Matuyama boundary with the earlier one as the locus of an event of normal polarity within the Matuyama, or place the boundary at 1 million years with an event of reversed polarity at about 0.8 million years within the Brunhes. The ANU group chose to wait for more data before deciding, while the Menlo Park group endorsed the first alternative despite the fact that they had no more or better data than those at ANU.

If the ANU group had opted for the first alternative and decided that the samples found on the road to Takamada indicated an event, Glen's book could have been entitled *The Road to Jaramillo and Takamada.* But they didn't, and Doell and Dalrymple threw caution by the roadside and named the second change as the Jaramillo because it made more stratigraphic sense. Thus, both groups discovered two reversals in polarity. In fact, the Menlo Park group discovered when the event ended, while the ANU group unearthed when it began. But the Menlo Park group was the first to name the event and stipulate the epoch boundary at 0.7 million years.

The ANU group deserves more credit than they have received, and certainly more than what one would think from reading *The Road to Jaramillo.* To put the point somewhat differently: If Vine had spoken with one of the ANU group about their discovery before speaking with Dalrymple, he would have realized immediately that sea floor spreading had occurred at a constant rate along the Juan de Fuca.

Rutten's Contribution

My third disagreement with Glen concerns his generally negative, albeit ambiguous, assessment of Martin Rutten's contribution to the development of the radiometric reversal time scale. The first time scale was developed by Rutten. Rutten, one of many Dutch earth scientists who played significant roles in the overall revolution, attacked a number of problems from different subdisciplines throughout his career. Like many others who played crucial roles in the development of continental drift and its more modern forms, Rutten is a generalist. Glen nicely explicates the development of Rutten's time scale, but he considers his effort premature and doesn't include the time scale in the chronology of those leading to the Jaramillo time scale. Glen describes his field work as simple and hurried, but also characterizes his work as astute. But Glen is quick to quote a rather damning, yet unattributed, comment by one of Rutten's coworkers, *alleging an inability by Rutten* to understand the technical aspects of paleomagnetism. I find this use of unattributed quotations disturbing, especially in this context, where it is used to denigrate an individual.

I think that Rutten deserves more credit than Glen is willing to give him, and that his time scale should be considered as the first in Glen's chronology. Rutten came up with the idea of developing a radiometric reversal time scale. As a generalist he was perceptive enough to see that combined research efforts in stratigraphy, paleomagnetism, and radiometric dating might produce a time scale. Moreover, he was ingenious enough to attack the problem without using sophisticated equipment. Armed with a field compass, expertise in the field, and knowledge of the literature, he developed the first radiometric time scale. Moreover, as Glen points out (p. 139), the Menlo Park group was "especially dependent upon Rutten's data" in the construction of their first time scale, and I would add that they continued to cite Rutten's findings in further time scales.

I consider Rutten's work good, innovative science. Glen finds it curious that Rutten never directly communicated with Curtis or with Evernden—the ultimate source of his radiometric dates—and that Rutten didn't continue developing time scales. Glen suggests that it was because Rutten realized "he personally lacked, and could not gain access to, the capabilities in radiometry and rock magnetism prerequisite to such an effort" (p. 139). I don't find Rutten's behavior curious. He couldn't get the needed sophisticated equipment. I don't know whether he could have gained the appropriate expertise. But, why should he bother? He knew that others who had the equipment were beginning work on the problem, and he already had worked out the conceptual relations among stratigraphy, paleomagnetism, and radiometric dating and had constructed the first time scale. Rutten is indeed a generalist in geophysics, not a specialist in some branch of it. He correctly understood his role as a generalist.

Lessons

So much for disagreements. There are two methodological "morals" that Glen touches upon in his book which should be of interest to readers of *Eos.* (1) Administrators of relatively small research units with limited funding shouldn't embark upon research programs already under way at larger institutions with seemingly unlimited funding; they should fund programs in new areas which have some promise of paying large dividends.

Books (cont. on p. 396)

EOS
Transactions, American Geophysical Union
The Weekly Newspaper of Geophysics
For full articles and meeting reports send one copy of the double-spaced manuscript to *Eos c/o* AGU at the address below and three copies to one of the editors, or send all four copies to *Eos.* For news items, send two copies of the double-spaced manuscript to *Eos.*
Editor-in-Chief: A. F. Spilhaus, Jr.; **Editors:** Marcel Ackerman, Mary P. Anderson, Peter M. Bell (News), Kevin C. Burke, Bruce Doe, Robert H. Eather (History), Clyde C. Goad, Arnold L. Gordon, Louis J. Lanzerotti. **Managing Editor:** Gregg Forte; **Editorial Assistant:** Kathleen M. Lafferty; **News Writer:** Barbara T. Richman; **News Intern:** Mario E. Godinez; **Production Staff:** James Hebblethwaite, Dae Sung Kim, Patricia Lichiello, Lisa Lichtenstein, Vivian Nelson.
Officers of the Union
James A. Van Allen, President; Charles L. Drake, President-Elect; Leslie H. Meredith, General Secretary; Carl Kisslinger, Foreign Secretary; A. F. Spilhaus, Jr., Executive Director; Waldo E. Smith, Executive Director Emeritus.
For advertising information, contact Robin E. Little, advertising coordinator, 202-462-6903.
Copyright 1983 by the American Geophysical Union. Material in this issue may be photocopied by individual scientists for research or classroom use. Permission is also granted to use short quotes and figures and tables for publication in scientific books and journals. For permission for any other uses, contact the AGU Publications Office.
Views expressed in this publication do not necessarily reflect official positions of the American Geophysical Union unless expressly stated.
Subscription price to members is included in annual dues ($20.00 per year). Information on institutional subscriptions is available on request. Second-class postage paid at Washington, D. C., and at additional mailing offices. *Eos, Transactions, American Geophysical Union* (ISSN 0096-3941) is published weekly by
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D. C. 20009

Cover. Deep-tow, high-resolution, 100-kHz side-scan sonar data have been gathered across the middle Mississippi fan, Gulf of Mexico, courtesy of Racal Geophysics, Inc. The detailed imagery is providing new perspectives on deep-sea fan morphology. The figure is a sonograph swath approximately 350 m wide showing a field of bedforms or 'sand waves' in a channel of water 2480 m deep. These very distinct features have wavelengths of about 20 m and heights of approximately 1 m; they compose localized areas, along with a variety of other bedform types, in the floor of the sinuous channel, which follows the axis of the fan. The channel has widths of 2–3 km and relief of 30–40 m. The orientation of the bedforms is generally perpendicular to the channel axis and follows the inferred direction of flow (arrow). The processes responsible for the channel, and associated bottom sediment forms, are the subject of continuing study. (Figure courtesy of David B. Prior, Charles E. Adams, and James M. Coleman, Coastal Studies Institute, Louisiana State University, Baton Rouge, LA 70803.)

Books (cont. from p. 395)

Nowhere is this methodological moral better exemplified than with John Jaeger at ANU. Jaeger pioneered work in heat flow. When he took over at ANU he hired a number of young researchers in peripheral areas of geophysics. Glen cites a wonderful passage from his interview with Ted Irving which explains Jaeger's rationale.

When I'd just arrived there, I asked Jaeger why he appointed the people who were there. One of the staff members was a geologist, one was an engineer, and there was myself, a sort of geologist cum geophysicist, and there was himself, an applied mathematician who was supposed to be running a geophysics department. He said to me: "Well, it's crazy to get into the classical areas of geophysics," that is, seismology and gravity and geomagnetism, the classical tripods of geophysics, "because if you get into the field you need enormous amounts of money and at least ten years before you become the least bit competitive. So what you should do is get into areas where people aren't." [Glen, p. 81]

Given the present state of funding for basic science, Jaeger's example is quite appropriate.

(2) Have researchers with expertise in various fields, or generalists, around when undertaking new research programs. This methodological moral is particularly relevant for earth scientists, since so many problems in the earth sciences are vulnerable to attack from many subfields.

There are numerous examples from the overall controversy over continental drift which substantiate this second moral. Arthur Holmes, for example, was well versed in geological and geophysical matters, while Sir Harold Jeffreys, whose accomplishments in developing a model for the earth's interior were monumental, cared little about geology and failed to appreciate some of the geological advantages of drift over fixism. Hess was accomplished in areas of geophysics and geology. Vine was a petrologist as well as a geophysicist. Irving, the first among the British directionalists to realize the use of directional studies for testing drift and to combine paleomagnetic and paleoclimatological studies, is both a geophysicist and geologist. Carey is a generalist.

All of these individuals stand in sharp contrast to many who opposed drift theory and sea floor spreading. Maurice Ewing was a geophysicist. Heirtzler, Le Pichon, and Talwani are geophysicists. So are Mason and Raff. Those without training in geology were, unlike their more geologically knowledgeable competitors, unable to appreciate the geological advantages of VMM and sea floor spreading. It is no accident that both groups concerned with the development of the reversal time scale were composed of individuals who knew some geology and were adept at paleomagnetism or radioactive dating. Then, of course, there was Rutten, a generalist of the first rank.

References

Chamalaun, F. H., and I. McDougall, Dating geomagnetic polarity epochs in Réunion, *Nature, 210*, 1212–1214, 1966.

Doell, R. R., and G. B. Dalrymple, Geomagnetic polarity epochs: A new polarity event and the age of the Brunhes-Matuyama boundary, *Science, 152*, 1060–1061, 1966.

Frankel, H., The development, reception, and acceptance of the Vine-Matthews-Morley hypothesis, *Hist. Stud. Phys. Sci., 13*, 1–39, 1982.

Laudan, R., The method of multiple working hypotheses and the development of plate tectonic theory, in *Scientific Discovery: Case Studies*, edited by T. Nickles, pp. 331–344, D. Reidel, Boston, 1980.

McDougall, I., H. L. Allsopp, and F. H. Chamalaun, Isotopic dating of the newer volcanics of Victoria, Australia, and geomagnetic polarity epochs, *J. Geophys. Res., 71*, 6107–6118, 1966.

McDougall, I., and H. Wensink, Paleomagnetism and geochronology of the Pliocene-Pleistocene lavas in Iceland, *Earth Planet. Sci. Lett., 1*, 232–236, 1966.

Henry Frankel is with the Department of Philosophy, University of Missouri-Kansas City, Kansas City, MO 64110. Research on which this review is partly based was funded by NSF.

New Publications

Items listed in New Publications can be ordered directly from the publisher; they are not available through AGU.

Industrial and Sewage Wastes in the Ocean, I. W. Duedall, B. H. Ketchum, P. K. Park, and D. R. Kester (Eds.), *Wastes in the Ocean*, vol. 1, John Wiley, New York, xii + 431 pp., 1983, $54.95.

North Sea Dynamics, J. Sündermann and W. Lenz (Eds.), Springer-Verlag, New York, xviii + 693 pp., 1983, $41.

Operation of Complex Water Systems: Operation, Planning, and Analysis of Already Developed Water Systems, E. Guggino, G. Rossi, and D. Hendricks (Eds.), Martinus Nijhoff, Boston, xxvi + 504 pp., 1983, $69.50.

Roadside Geology of Arizona, H. Chronic, Mountain Press, Montana, xiv + 314 pp., 1983, $9.95.

Tidal Friction and the Earth's Rotation II, P. Brosche and J. Sündermann (eds.), Proceedings of a Workshop Held at the Centre for Interdisciplinary Research (ZiF) of the University of Bielefeld, September 28–October 3, 1981, Springer-Verlag, New York, xv + 345 pp., $28.

Tornados, Dark Days, Anomalous Precipitation, and Related Weather Phenomena: A Catalog of Geophysical Anomalies, R. Corliss, The Sourcebook Project, Glen Arm, Md., vi + 196 pp., 1983, $11.95.

Tracers in the Sea, W. S. Broecker and T.-H. Peng, Lamont-Doherty Geological Observatory, Columbia University, Palisades, New York, xiv + 692 pp., 1982.

Urban Stormwater Hydraulics and Hydrology, Proceedings of the 2nd International Conference on Urban Storm Drainage held at Urbana, Ill., June 15–19, 1981, B. C. Yen (Ed.), Water Resources Publications, Littleton, Colo., viii + 547 pp., 1982.

Urban Stormwater Quality, Management and Planning, Proceedings of the 2nd International Conference on Urban Storm Drainage held at Urbana, Ill., June 15–19, 1981, B. C. Yen (Ed.), Water Resources Publications, Littleton, Colo., viii + 593 pp., 1982.

Venus, D. M. Hunten, L. Colin, T. M. Donahue, and V. I. Moroz (Eds.), University of Arizona Press, Tucson, viii + 1143 pp., 1983.

Classified

RATES PER LINE

Positions Wanted: first insertion $1.75, additional insertions $1.50.

Positions Available, Services, Supplies, Courses, and Announcements: first insertion $3.50, additional insertions $2.75.

Student Opportunities: first insertion free, additional insertions $1.50.

There are no discounts or commissions on classified ads. Any type style that is not publisher's choice is charged for at general advertising rates. Eos is published weekly on Tuesday. Ads must be received in writing on Monday, 1 week prior to the date of publication.

Replies to ads with box numbers should be addressed to Box ___, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D. C. 20009.

For further information, call toll free 800-424-2488 or, in the Washington, D. C., area, 462-6903.

POSITIONS AVAILABLE

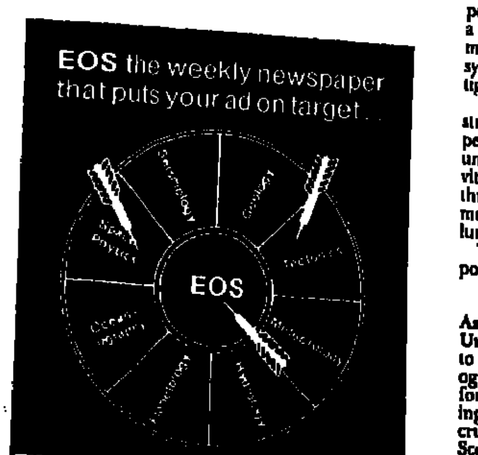
Chairman—Department of Geological Sciences, Wright State University. The Department of Geological Sciences, invites applications for the position of chairman, to be appointed September 1984. We seek a dynamic individual with administrative talent and an appreciation for research and practice-related educational activities. Rank is at the full professor level and no restrictions have been placed in the area of specialization. The department is active with 12 faculty and an emphasis on professional practice, yet maintaining a firm commitment to basic research.

Send a letter of application, curriculum vitae and names of three references to:

Chairman, Search Committee
Department of Geological Sciences
Wright State University
Dayton, OH 45435.

Wright State University is an affirmative action/equal opportunity employer. Closing date for the position is October 31, 1983.

EOS the weekly newspaper that puts your ad on target



Advertise in EOS—the proven way to get your message across to these specially targeted audiences.

For rates, information, or to place your ad, call:

Robin Little
Advertising Coordinator
800-424-2488 or 462-6903 (local)

... and hit the bull's-eye with your message!

AGU

Research Associate/Petrography-Petrology. To join a research effort aimed at understanding the condensation history of the solar system by mineralogical, chemical, and isotopic studies of tiny inclusions in primitive meteorites. Applicant need not have previous experience with meteorites but should be a superb petrographer, skilled in the use of the SEM and electron probe. Successful candidate will be dedicated, productive, an effective communicator both orally and in writing, and will have Ph.D. in hand. Vacancy expected in late summer or early autumn 1983.

Send resume and names of three references to: L. Grossman, Department of the Geophysical Sciences, University of Chicago, 5734 S. Ellis Avenue, Chicago, IL 60637.

The University of Chicago is an equal opportunity/affirmative action employer.

Faculty Position for HREM Specialist/Arizona State University. A tenure-track faculty position at the Associate or Assistant Professor level is available at Arizona State University for a high-resolution electron microscopy specialist to work with the ASU Facility for High Resolution Electron Microscopy within the Center for Solid State Science. The appointee will hold academic rank and will teach within the university department appropriate to his/her expertise. Qualifications include a doctoral degree in an appropriate area of science, a record of achievement and publication in high resolution electron microscopy and knowledge of related techniques such as microanalysis and microdiffraction. It is expected that the appointee will institute an active research program in electron microscopy or its application in some area of solid state science using the instrumentation of the Facility and will serve as adviser to Facility users.

Send resume and arrange for three letters of recommendation to be sent to: J.M. Cowley, Center for Solid State Science, Arizona State University, Tempe, AZ 85287, before August 30, 1983.

Arizona State University is an equal opportunity/affirmative action employer.

Faculty Position in Sedimentary Geology at the University of South Carolina. Applications are invited for a tenured track faculty position in the Department of Geology with a specialization in sedimentology starting as early as August 1983. Ph.D. required. Rank and salary are open depending on qualifications and experience. We seek a candidate whose research interests are in one or more of the following fields: carbonate depositional systems, basin analysis, global sediment cycling, stratigraphy and sedimentary geochemistry. The successful candidate is expected to develop a strong research program with external funding, supervise graduate students, and teach graduate and undergraduate courses. Send letter of application, vitae, statement of research interests, and names of three references to: Dr. Robert G. Thunell, Department of Geology, University of South Carolina, Columbia, SC 29208.

The University of South Carolina is an equal opportunity/affirmative action employer.

Assistant Professor/Crustal Reflection Seismology/University of Wyoming. A non-tenured position to conduct and direct research in reflection seismology is likely to become available on 1 August 1983 for a period of two years. Project involves processing and interpretation of COCORP and other deep crustal reflection data with Robert Burridge and Scott Smithson as the principal investigators. Ph.D. or expected completion within six months required. Applicant must be experienced in processing and interpreting crustal reflection data. Responsibilities include supervising graduate students and conducting own research in processing and/or interpretation. Opportunity to become involved in an integrated approach to reflection seismology working with colleagues in electrical engineering and mathematics and to become involved in seismic data acquisition. Deadline for applications is July 1, 1983. Interested applicants send a resume and names of three references to:

Scott Smithson
Department of Geology and Geophysics
University of Wyoming
P.O. Box 3006, University Station
Laramie, WY 82071

The University of Wyoming is an equal opportunity/affirmative action employer.

Research Scientist/Space Plasma Physics, University of Iowa. A research position is available in the Department of Physics and Astronomy, The University of Iowa, for theoretical and interpretative studies of waves in space plasmas. Specific emphasis is on theoretical investigations of wave-particle interactions in planetary magnetospheres and in the solar wind. These investigations are to support the interpretation of data being obtained from spacecraft such as Dynamics Explorer, International Sun Earth Explorer and Voyager. The applicant must have a Ph.D. with good qualifications in plasma physics theory and should have some experience in the interpretation of space plasma physics data.

Send a resume and the names of three references familiar with the applicant's work to: D.A. Gurnett, Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242, telephone 319-353-3527.

The University of Iowa is an affirmative action/equal opportunity employer.

Director/Geophysical Fluid Dynamics Laboratory/The Environmental Research Laboratories, NOAA. The U.S. Department of Commerce in Princeton, New Jersey, is seeking applicants for a scientific manager to serve as Director, Geophysical Fluid Dynamics Laboratory. The Director conceives, implements, and evaluates research programs to expand the scientific understanding of those physical processes which govern the behavior of the atmosphere and the oceans as complex fluid systems. This involves extensive inter- and intra-agency coordination as well as the direction of a 100-member staff engaged in research activities. Position is Career Reserved in the Senior Executive Service. Salary range: $56,945 to $67,200 per annum—negotiable based on experience, scientific achievement, and technical/managerial qualifications.

QUALIFICATIONS: Knowledge of theory and state of the art in a combination of disciplines (meteorology, oceanography, hydrology, classical physics, fluid dynamics, chemistry, and applied mathematics) to design, direct, and evaluate interdisciplinary research programs. Competence in the scientific management of theoretical and experimental research studies of a large-scale nature. Personal research in meteorology or oceanography. Executive competence in broad areas of administration such as program planning and evaluation, intelligent coordination, resource acquisition and administration, organizational representation, and human resource utilization including EEO.

TO APPLY: Interested persons should contact Ms. Barbara J. Peterson, NOAA/ERL, Personnel Services Division (R/E562), 325 Broadway, Boulder, CO 80303 (303) 497-6780 or FTS 320-6780 for application forms. Reference Vacancy #NOAA/ERL 82-269. Position announcement closes July 8, 1983.

AN EQUAL OPPORTUNITY EMPLOYER.

University of Colorado, Boulder, Geochemist Position. Geochemist with active research program, stable isotopes, radioactive isotopes, and/or trace elements is being sought for a joint appointment in the Department of Geological Sciences and the Cooperative Institute for Research in Environmental Sciences (CIRES) of the University of Colorado.

The one-half time position within the Department of Geological Sciences is tenure track at the assistant or associate professor level with a starting salary of $12,000–$15,000 for the academic year.

Teaching load will be half that of full-time faculty. The position within CIRES will be at a Fellow with appropriate office and laboratory space. One-half academic year salary will be guaranteed by CIRES for two years at the departmental rate, after which incumbent must generate his/her CIRES salary from external sources. Incumbent may augment salary further by generating three months of summer salary from contracts and grants, and consulting.

Applicants with experience, publications, and/or movable existing research equipment preferred. Preferred starting date would be January 1, 1984. Closing date for applications is October 1, 1983.

Application should include statement of research and teaching interests, experience, a full vitae, and four letters of reference.

Apply to: Professor Charles Stern, Chairman, Geochemist Search Committee, Department of Geological Sciences, Campus Box 250, University of Colorado, Boulder, CO 80309.

The University of Colorado is an equal opportunity/affirmative action, Section 504 employer.

Research Associate. The Stanford University School of Earth Sciences and the Center for Materials Research seek a research associate for an initial three-year appointment to start approximately 1 October 1983 whose responsibilities will include (1) supervision and maintenance of a new XRF-XRD facility.

(2) Supervision of a new ESCA spectrometer, and (3) interaction with our microprobe technician in optimizing software for geological applications.

Duties will include training faculty and students in use of the XRF, XRD, and ESCA, but not service work. Experience in operation of XRF, XRD, and/or electron microprobe required; we will train on the ESCA. A good working knowledge of DEC Series 11 computers (11/02, 11/23, 11/34) operating under the RSX-11M monitor and of FORTRAN level programming is essential. Although we envision that the duties associated with this new equipment will constitute a full-time job for a year or two, we prefer Ph.D. level applicants who desire eventually to develop their own research program in conjunction with Stanford geology faculty.

Send C.V. to Gail Mahood, Department of Geology, Stanford University, Stanford, CA 94305.

Stanford University is an equal opportunity/affirmative action employer.

Atmospheric Modeler/Programmer. Atmospheric and Environmental Research, Inc. has a staff position opening on a project to enhance the availability and forecast capabilities of an NWP spectral model by maximizing the model's use of satellite data. The position is for a recent PhD or experienced MS in meteorology or related field with an active interest in global numerical weather prediction. We are especially interested in individuals with expertise in one or more of the following areas: normal mode initialization, optimal interpolation, cloud parameterization and forecasting, boundary layer processes. Computer proficiency is a must. Experience with Harris and/or CRAY hardware is desirable. Stimulating, academic-style research environment. Please send resume and names of three references to: Dr. Lewis Kaplan, Principal Scientist, Atmospheric and Environmental Research, Inc., 840 Memorial Drive, Cambridge, MA 02139. Telephone 617-547-6207.

Research Positions for Mathematical Physicists. Applications are invited for several research positions at the Center for Studies of Nonlinear Dynamics, La Jolla Institute, beginning summer 1983. Current research involves work on nonlinear wave-wave interactions, acoustic, optical, and radio wave propagation in random media, and turbulence phenomena in the statistical mechanics of chemical and geophysical systems. Physicists and applied mathematicians who are interested in working on problems of the above type should send resume and arrange for three letters of recommendation to be sent to Dr. Stanley Flatte, Director, CSND, La Jolla Institute, 8950 Villa La Jolla Drive, Suite B124, La Jolla, California 92037.

La Jolla Institute is an equal opportunity/affirmative action employer.

Postdoctoral Position in Physical Oceanography. A postdoctoral appointment in physical oceanography will be available beginning September 1983 in the College of Marine Studies, University of Delaware, Newark, DE. The initial appointment will be for one year with probable extension for a second year. The salary will be $20,000–$24,000 per year depending on experience. Funds for the position will be available largely from a grant by NSF to conduct and analysis of a field observational study of the shelfbreak front in the Middle Atlantic Bight.

The person obtaining the appointment would be responsible for a portion of the planning and execution of the field study, much of the subsequent data analysis and interpretation, and teaching of one graduate level course in physical oceanography each year. The successful applicant must have received the Ph.D. in physical oceanography or a closely related field by the starting date of the appointment. Preference will be given to applicants with direct experience in field observations.

To apply send a complete resume and the names of three references to: Professor R.W. Garvine, College of Marine Studies, University of Delaware, Newark, DE 19711. (Telephone) 302-738-2169.

The University of Delaware is an equal opportunity/affirmative action employer.

Assistant Professor/Instructor in Meteorology. September 1, 1983. Department of the Earth Sciences has position primarily concerned with the teaching of the synoptic meteorology aspect (Synoptic Meteorology, Weather Forecasting Laboratory) of the undergraduate Meteorology Major program. The successful applicant should also be capable of teaching two or more courses in air pollution meteorology, advanced forecasting techniques, and computer applications. Will also assume the directorship of the College Weather Center. An earned doctorate in Meteorology or allied field preferred, with strong background in synoptic meteorology and computer applications. Experience in weather forecasting and teaching desirable.

A letter of application, resume, and three letters directly from references should be sent to: Office of Faculty and Staff Relations, 4th Floor, Administration Building, State University College, Brockport, NY 14420. Closing date for receipt of applications July 10, 1983.

State University of New York College at Brockport is an Equal Opportunity/Affirmative Action Employer.

National Museum of Natural History/Smithsonian Institution. The Department of Mineral Sciences seeks applicants for two tenure-track research positions on our professional staff in mineralogy, petrology, geochemistry, or meteoritics. Although primarily research oriented, the jobs will also include some involvement with other important museum functions, most notably collections curation and/or public education, particularly exhibits. A Ph.D. and broad interests in the geosciences are preferred. Appointments will be made at the GS-11 level ($24,508). One position available immediately; one position available after January 1, 1984 (with some flexibility in both starting dates). Closing date for applications is July 29, 1983.

The Department's collections of minerals, rocks, meteorites, and tektites are among the largest and finest in the world. The Department is well-equipped with modern analytical instruments including an automated electron microprobe. Close working relationships with other parts of Washington's extensive geologic community further extend the available facilities and expertise.

Applicants should send a resume (including a statement of research interests), the names of three references and a completed SF-171 form (or a request for said form) to: Office of Personnel Administration (MS), ATTN: Room 1413 A&I, Smithsonian Institution, Washington, DC 20560.

The Smithsonian Institution is an equal opportunity/affirmative action employer.

Structural Geology/Petrology. Lafayette College seeks a person to teach undergraduate physical and structural geology, igneous and metamorphic petrology, and additional courses, dependent on applicant's interests. Ability to teach introductory geophysics is desirable but not mandatory. Teaching load averages ten to twelve contact hours and two courses/semester. Appointment as assistant professor (Ph.D. complete) or instructor (Ph.D. pending). Send application and resume, and arrange for three reference letters to Dr. Richard W. Faas, Department of Geology, Lafayette College, Easton, PA 18042.

Lafayette College is an equal opportunity employer. M/F. Women and minorities are encouraged to apply.

Research Faculty Position in Space Physics/Boston University. The Astronomy Department at Boston University expects to have a research faculty position available for the 1983/84 academic year.

Applicants are sought who have a proven research record as evidenced by publications and recommendations and who have an interest in teaching at the graduate and undergraduate level. Applicants with research programs in any area of space physics will be considered; however, preference will be given to those with interests in ionospheric or magnetospheric space plasma physics. Rank will depend on qualifications and experience.

Applicants are particularly sought who can bring partial salary support. Teaching duties are based on the proportion of salary supported by departmental funds.

Please send a curriculum vitae, names of three persons who can provide an evaluation of your teaching and research and a brief statement of current research interests to:

Kenneth Janes, Chairman
Astronomy Department
Boston University
725 Commonwealth Avenue
Boston, MA 02215
(617)353-2627.

Boston University is an equal opportunity/affirmative action employer.

Howard University/Graduate Faculty Position. The Department of Geology/Geography invites applications for a tenure-track position in geochemistry at rank of assistant or associate professor beginning August 1983. Position involves development of graduate research program at Master's level. Desired specialization includes environmental geochemistry, geochronology, isotope geology. Send letter of application, resume and names of three references to Dr. David Schwartzman, Department of Geology/Geography, Howard University, D.C. 20059.

Department of Scientific & Industrial Research/Research Scientist in Geomagnetism, Physics & Engineering Laboratory, Christchurch, New Zealand. The Research Section of the Physics and Engineering Laboratory, Geophysical Observatory in Christchurch has a vacancy for an atmospheric physicist to join a research group, currently working on projects related to the International Middle Atmosphere programme. An extensive database of geomagnetic and ionospheric records is available.

Qualifications: Post Doctorate research experience in an appropriate field.

Salary up to NZ$33,333 per annum depending on qualifications and experience.

Further information, application forms etc., may be obtained from The Ambassador, New Zealand Embassy, Washington, D.C. Applicants should quote vacancy number 1736 and forward applications accompanied by a resume to:

The Ambassador
New Zealand Embassy
37 Observatory Circle NW
Washington, D.C. 20008.

APPLICATIONS MUST ARRIVE BY JULY 14, 1983.

STUDENT OPPORTUNITIES

Graduate Assistantships/Howard University. Howard University in Washington, D.C., offers a new graduate program for the M.S. degree in geoscience; made possible by a grant from the Gulf Oil Company. Areas of specialization are field geology/geophysics, geochemistry, and meteorology/hydrology with remote sensing. Some stipends and assistantships are available. Potential students should write to Dr. Eric Christofferson, Department of Geology and Geography, Howard University, Washington, D.C. 20059.

AGU

Membership Applications Received

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary section affiliation; the letter A denotes the Atmospheric Sciences section, which was formerly the Meteorology section.

Regular Member

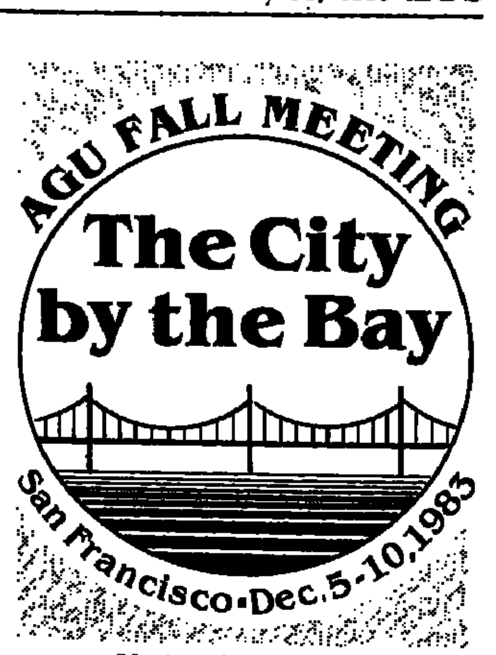
Robert W. Blake (T), Jeff P. Calebaugh (G), Mark Cane (O), Peishan Chen (S), Barbara A. Cosens (V), Steven Courteney (T), D. W. Edgerley (T), Dale L. Erlandson (T), Wolfgang Gringel (A), Russell S. Harmon (V), John W. Knox (T), Lois Luedemann (A), Jerry D. Mahlman (A), Gary A. Maykut (O), Henryk Mozman (S), Badaoui M. Rouhban (S), Uta Schmailzl (A), Gautam Sen (V), Edward L. Smith (O), Bong Chool Suk (O), Kenneth R. Walters (A), Paul A. Washington (T), L. J. Wiggins (S), Jurgen Wohlenberg.

Student Member

Omar Aboulabbes (H), Stephen R. Addison (S), K. A. Albrecht (H), Carlos R. Cobos (H), Jeffrey Cornwell (O), Ilham Demir (V), Frank M. Gaweda (H), Bradley R. Hacker (T), Cheryl L. Klobcar (V), Barbara Marcotte (H), David G. Markham (O), Kevin Lee Mickus (G), Thomas Nakaki (S), John Piggott (P), Jerome T. Prosser (V), Eleanour Snow (V), Peter F. Spain (O), Reidar G. Tronnes (V), Terry A. Whelan (SM).

Associate Member

Emmanuel V. Tamesis (T).



Abstract Deadline: September 14

Call for Papers to be Published in EOS June 28

Meetings

Meeting Report

High-Latitude Radiowaves

The first International URSI Symposium covering high-latitude radiowave studies of the atmosphere from the troposphere to the magnetosphere was held at the Geophysical Institute of the University of Alaska in Fairbanks, August 9–13, 1982. The symposium was directed toward the new radio techniques that have been developed, many in the past two or three years, for probing the atmosphere from high geomagnetic latitudes. These systems include the VHF Mesosphere/Stratosphere/Troposphere (MST) radar, the European scatter radars, a new generation of HF digital ionospheric sounders, HF ionospheric 'heaters' and VHF coherent oblique backscatter radars (STARE and SABRE).

The purpose of this URSI symposium was to present and discuss results obtained with these new techniques and to work toward putting together coherent, consistent models of a high-latitude atmospheric structure and dynamics using these new results. It also provided an opportunity for meetings of special URSI working groups.

The symposium was divided into seven minisymposia and a closing summary session. The sessions were as follows: Modification Experiments; Methods of High-latitude Radiowave Research; Solar Cycle Variations of the High-Latitude Ionosphere; Radiowave Probing of Boundaries in the Magnetosphere–Ionosphere System; Radiowave Studies of the Disturbed Polar Ionosphere; The Neutral Atmosphere; Irregularities Large and Small; and Future Directions.

Many of the results presented at this symposium, including the presentations given in the session on future programs, are presently being compiled for a special issue of *Radio Science*, scheduled for publication in late 1983.

This meeting report was prepared by R. D. Hunsucker *of the Geophysical Institute, University of Alaska, Fairbanks, AK 99701, and* Ray Greenwald *of the Applied Physics Laboratory, Johns Hopkins University, Laurel, MD 20810.*

Announcements

Collisionless Shock Waves in Heliosphere

A Chapman Conference on Collisionless Shock Waves in the Heliosphere will be held in Napa Valley, Calif., February 20–24, 1984, to bring together interested investigators. The conference is to provide timely impetus to the development of newly emerging research and to initiate communications and interaction between scientists from related, but separate, fields. The deadline for abstracts is November 1, 1983.

The meeting will feature tutorial sessions as well as invited reviews and contributed papers in the following general areas: Overview of the collisionless shock, macroscopic aspects of shocks, microscopic aspects of shocks and particle acceleration.

Typical subjects to be covered include: why and where shocks form in the heliosphere; shock dynamics and evolution; shocks associated with solar activity, planetary bow shocks, corotation shocks, and shock-shock interactions; subcritical, supercritical, quasi-parallel and quasi-perpendicular shocks; dissipation mechanisms; the foreshock; and particle acceleration mechanisms. The meeting will include morning sessions plus a mixture of afternoon and evening sessions that will leave adequate time for discussion. Poster papers will be encouraged and will be previewed and displayed.

There will be no parallel sessions. All papers presented should interest all attendees. There will also be a review and discussion of all poster paper sessions. It is anticipated that the conference will provide the basis of a monograph on the subject.

To submit a paper, follow the standard AGU format published in the April 5, 1983, issue of *Eos*. Please send the original and two copies to the convenor: R. G. Stone, Code 690, NASA/Goddard Space Flight Center, Greenbelt, MD 20771.

Formal notification of acceptance will be sent about 1 month after the abstract deadline. Because of the anticipated demand, papers will be selected based on their relevance to the general conference outline.

The Program Committee is as follows: Kinsey Anderson, University of California, Berkeley; Leonard Burlaga, NASA/Goddard Space Flight Center; Charles Goodrich, University of Maryland; John Gosling, Los Alamos National Laboratory; E. Greenstadt, TRW; Arthur Hundhausen, High Altitude Observatory; Keith Ogilvie, NASA/Goddard Space Flight Center; C. T. Russell, UCLA; Jack Scudder, NASA/Goddard Space Flight Center; Edward Smith, JPL Caltech; Robert Stone, NASA/Goddard Space Flight; Bruce Tsurutani, JPL Caltech; K. Peter Wenzel, ESTEC.

Limited funding is available to support student travel expenses to the conference. To apply, write to AGU giving your educational background, your reasons for wanting to attend the conference, and your research interests. The awardees will be selected by AGU in conjunction with the program committee. Deadline for travel applications is September 30.

All interested in attending and in receiving later information circulars should write to Shocks in the Heliosphere Meeting, AGU, 2000 Florida Ave., N.W., Washington, DC 20009 (telephone, toll free, 800-424-2488 or, in the D.C. area, 462-6903).

Multivariate Modeling of Time Series

A special session entitled "Multivariate Modeling of Hydrologic and Other Geophysical Time Series" will be held during the AGU Fall Meeting in San Francisco December 5–9, 1983. This special session is sponsored by the Surface Runoff Committee of the Hydrology Section of AGU.

The purpose of this special session is to bring together individuals from different disciplines to discuss the state of the art and new developments in stochastic description and modeling in time (and/or in space) of multiple time series of hydrologic and geophysical phenomena.

Several models and modeling techniques have been proposed for representing univariate and multivariate time series with applications in hydrology and geophysics. However, even when modeling single time series there are still a number of unresolved or controversial questions which merit further studies and discussions.

This situation is compounded when dealing with multiple time series. As the models attempt to incorporate more statistical features of the historical time series, the number of parameters increases; in turn, the mathematics of the model becomes cumbersome and the identification and estimation procedures more difficult. Under these circumstances the testing of goodness of fit of the models is more complex and the problem of how to deal with various types of uncertainties often becomes unmanageable.

Possible topics for this special session include: multivariate model identification techniques, parameter estimation procedures, model testing and validation techniques, discrete and continuous models, ARMA and non-ARMA models, Gaussian and non-Gaussian models, models with periodic and non-periodic parameters, aggregation and disaggregation techniques, sensitivity analysis, modeling of uncertainties, Bayesian and non-Bayesian techniques, models for transfer of information, models for detection of changes and models for data generation and forecasting.

Abstracts, in standard AGU format, should be mailed to the session organizer: Jose D. Salas, Department of Civil Engineering, Colorado State Univ., Fort Collins, CO 80523. The deadline is August 15, 1983. In addition, the abstract original and two copies must be sent to Meetings, AGU, 2000 Florida Avenue, N.W., Washington, DC 20009 by September 14. Additional information can be obtained from J. D. Salas, telephone (303) 491-8460 or 6047.

Irrigation and Drainage

The 12th International Congress on Irrigation and Drainage will be held May 28–June 2, 1984, in Fort Collins, Colo. The meeting will provide an open forum in the areas of irrigation, drainage, and flood control.

Among the topics for discussion are the international cooperation in water management; irrigation and drainage of fine-textured (heavy) soils and soils with shallow, impermeable barriers; irrigation and drainage of saline and alkaline soils; and irrigation and drainage of coarse-textured (sandy) soils. A special session will discuss the impact of the energy crisis on irrigation and drainage. The theme for one planned symposium is 'New Developments in the Protection of Irrigation, Drainage, and Flood Control Structures of Rivers.'

A product exhibition will be held during the meeting; study tours will be offered before and after the meeting. The meeting is sponsored by the U.S. Committee on Irrigation, Drainage, and Flood Control, which is the U.S. National Committee of the International Commission on Irrigation and Drainage.

For additional information contact the U.S. Committee on Irrigation, Drainage, and Flood Control, P.O. Box 15326, Denver, CO 80215.

Geophysical Year

Boldface meeting titles indicate meetings sponsored or cosponsored by AGU. A list of organization abbreviations appears at the end of the Geophysical Year list.

1983

June Ninth Conference of Aerospace and Aeronautical Meteorology, Omaha, Neb. Sponsor, American Institute of Aeronautics and Astronautics and AMS. (AIAA, Meeting Dept., 1290 Avenue of the Americas, New York, NY 10019, or AMS, 45 Beacon St., Boston, MA 02108.)

June 12–25 Seventh Annual Conference, Kingston, R.I. Sponsor, Univ. of Rhode Island, Center for Ocean Management Studies. (Center for Ocean Management Studies, Kingston, RI 02881.)

June 13–15 **International Symposium on Gas Transfer at Water Surfaces**, Ithaca, N.Y. Sponsors, ACS, AMS, ASCE, International Association for Hydraulic Research, U.S. Environmental Protection Agency, National Science Foundation, WMO, AGU. (W. H. Brutsaert or G. H. Jirka, School of Civil and Environmental Engineering, Cornell Univ., Ithaca, NY 14853.)

June 13–17 Outstanding Problems in the Magnetosphere-Ionosphere-Atmosphere System, Gordon Research Conference in Space Plasma Physics, Plymouth, N.H. (Stanley D. Shawhan, Dept.

Meetings (cont. on p. 398)

Meetings (cont. from p. 397)

of Physics and Astronomy, Univ. of Iowa, Iowa City, IA 52242 or Thomas J. Birmingham, Code 695, NASA/Goddard Space Flight Center, Greenbelt, MD 20771.)

June 13–Aug. 26 Gordon Research Conferences, various sites in New Hampshire. (Alexander M. Cruickshank, Director, Gordon Research Conferences, Univ. of Rhode Island, Kingston, RI 02881; telephone: 401-783-4011 or 783-3372.)

June 14–24 Turbulence and Predictability in Geophysical Fluid Dynamics, Varenna, Italy. Sponsors, Italian Physics Society, Italian Ministry of Public Instruction, Consiglio Nazionale delle Ricerche, U.S. National Science Foundation, National Aeronautics and Space Administration, and AMS. (R. Benzi, Scientific Service, Centro Scientifico IBM, Via del Giorgione 129, 00147 Rome, Italy.)

June 15–17 Third International Symposium on Computer-Aided Seismic Analysis and Discrimination, Washington, D.C. Sponsors, IEEE Computer Society, Pattern Recognition Society, IEEE Acoustic, Speech and Signal Processing Society, IEEE Geoscience and Remote Sensing Society, Dept. of Electrical Engineering, Catholic Univ. of America. (C. H. Chen, Electrical Engineering Dept., Southeastern Massachusetts Univ., N. Dartmouth, MA 02747 or R. C. Olson, Mar Associates, Inc., 1335 Rockville Pike, Rockville, MD 20852.)

June 18–22 Fifth International Conference on Finite Elements in Water Resources, Burlington, Vt. (J. P. Laible, Finite Element Conference, Dept. of Civil Engineering and Mechanical Engineering, Univ. of Vermont, Burlington, VT 05405.)

June 19–24 64th Annual Meeting of the Pacific Division of AAAS and the 59th Annual Meeting of the AAAS Southwestern and Rocky Mountain Division, Logan, Utah. Sponsor, AAAS Pacific and Western divisions. (Alan E. Leviton, Executive Director, AAAS (Pacific Division), California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118; M. Michelle Balcomb, Executive Officer, AAAS (Southwestern and Rocky Mountain Division), Colorado Mountain College, 3000 Country Rd. 114, Glenwood Springs, CO 81601.)

June 19–28 17th Congress of the International Federation of Surveyors (FIG), Sofia, Bulgaria. (108, rue Rakovski, B. P. 1386, 1000 Sofia, Bulgaria.)

June 20–22 American Astronomical Society Meeting, St. Paul, Minn. (Harry Shipman, Education Officer, AAS, Univ. of Delaware, Newark, DE 19711; telephone: 302-738-2986 or 738-8749.)

June 20–23 24th U.S. Symposium on Rock Mechanics, College Station, Tex. Sponsor, Texas A&M Univ. in cooperation with the Center for Energy and Mineral Resources, Office of Continuing Education, Association of Engineering Geologists, U.S. National Committee for Rock Mechanics of the National Research Council. (Organizing Committee, 24th U.S. Symposium on Rock Mechanics, c/o Earl Hoskins, Dept. of Geophysics, Texas A&M Univ., College Station, TX 77843.)

June 21–23 International Aerospace and Ground Conference on Lightning and Static Electricity, Fort Worth, Tex. Sponsor, National Interagency Coordination Group of the National Atmospheric Electricity Hazards Protection Program in concert with the Florida Institute of Technology. (N. Rasch, Conference Chairman, FAA Technical Center, ACT-340, Atlantic City Airport, NJ 08405; W. McKerchar, Conference Coordinator, c/o Northwest Engineering Service, P.O. Box 1888, Poulsbo, WA 98370, or J. J. Fisher, Executive Vice Chairman and Treasurer, U.S. Naval Air Systems Command, Washington, DC 20361.)

June 21–23 Ninth International Symposium on Machine Processing of Remotely Sensed Data, West Lafayette, Ind. Sponsor, Purdue Univ. Laboratory for Applications of Remote Sensing. (D. B. Morrison, Symposium Coordinator, Purdue Univ./LARS, 1220 Potter Dr., West Lafayette, IN 47906.)

June 21–24 Fifth Conference on the Physics of the Jovian and Saturnian Magnetospheres, Cambridge, Mass. (H. S. Bridge, 37-241, MIT, Cambridge, MA 02139.)

July 4–7 Third River Basin Management Conference, York, UK. (D. H. Newsome, 7th Floor, Reading Bridge House, Reading, Berks, UK.)

July 4–7 International Colloquium CNRS Petrology of Weathering and Soils, Paris, France. (D. Nahon, Laboratoire de Pétrologie de la Surface, Université de Poitiers, 40, Avenue Recteur Pineau, 86022 Poitiers Cedex, France.)

July 5–8 International Conference on Natural Satellites, Ithaca, N.Y. Sponsors, Division for Planetary Sciences of the American Astronomical Society, AGU. (J. A. Burns, Space Sciences Building, Cornell Univ., Ithaca, NY 14853 or D. Morrison, Institute for Astronomy, 2680 Woodlawn Dr., Honolulu, HI 96822.)

July 6–8 National Conference on Environmental Engineering, Boulder, Colo. Sponsor, Environmental Engineering Division of the ASCE. (Allen J. Medine, Conference Chairman, Campus Box 428, Univ. of Colorado, Boulder, CO 80309; telephone: 303-492-6069.)

July 11–13 Summer Computer Simulation Conference, Vancouver, B. C., Canada. Sponsor, Society for Computer Simulation. (SCS, P.O. Box 2228, La Jolla, CA 92038.)

July 13–15 International Symposium on Salinity Control, Salt Lake City, Utah. Sponsors, Bureau of Reclamation, Army Corps of Engineers, EPA, Office of Water Research and Technology, Dept. of Agriculture, Colorado River Basin Salinity Control Forum. (J. H. French, Water Resources Center, 1500 E. Tropicana Ave., Suite 201, Las Vegas, NV 89109.)

July 18–20 Applied Probability in Biology and Engineering, Lexington, Ky. Sponsor, ORSA/TIMS. (J. Gani, Organizing Chairman, Dept. of Statistics, Univ. of Kentucky, 857 Patterson Office Tower, Lexington, KY 40506.)

July 18–22 Fourth International Conference on Permafrost, Fairbanks, Alaska. (L. De Goes, Polar Research Board, National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, DC 20418.)

July 19–21 First International Conference on Paleoceanography, Zurich, Switzerland. ([illegible], ETH-Zentrum, 8092 Zurich, Switzerland.)

July 25–28 10th International Symposium on Urban Hydrology, Hydraulics, and Sediment Control, Lexington, Ky. Sponsor, AGU. ([illegible], Dept. of Civil Engineering, Univ. of Kentucky, Lexington, KY 40506-0046.)

Aug. 15–26 18th General Assembly of IUGG, Hamburg, FRG. (Dr. H. J. Liebscher, Federal Institute of Hydrology, Kaiserin-Augusta-Anlagen 15, Koblenz D34, FRG.)

Aug. 15–27 Symposium on Atmospheric Ice Crystals and Haze in the Polar Regions, IUGG General Assembly, Hamburg, FRG. Sponsors, International Commission on Atmospheric Chemistry and Global Pollution and International Commission on Polar Meteorology (ICPM). (G. Weller, President, ICPM, Geophysical Institute, Univ. of Alaska, Fairbanks, AK 99701 or M. Kuhn, ICPM Secretary, Institut für Meteorologie und Geophysik, Schöpfstrasse 41, A-6020 Innsbruck, Austria.)

Aug. 15–27 Symposium on Polar Meteorology and Climate, IUGG General Assembly, Hamburg, FRG. Sponsors, Scientific Committee on Antarctic Research and International Commission on Polar Meteorology (ICPM). (G. Weller, President, ICPM, Geophysical Institute, Univ. of Alaska, Fairbanks, AK 99701 or M. Kuhn, ICPM Secretary, Institut für Meteorologie und Geophysik, Schöpfstrasse 41, A-6020 Innsbruck, Austria.)

Aug. 15–27 Symposium on Hydrological Applications of Remote Sensing and Remote Data Transmission, IUGG General Assembly, Hamburg, FRG. Sponsors, International Committee on Remote Sensing and Data Transmission for Hydrology of IAHS, World Meteorological Organization. (A. I. Johnson, President, International Committee on Remote Sensing and Data Transmission, Woodward-Clyde Consultants, Harlequin Plaza-North 7600 East Orchard Rd., Englewood, CO 80111.)

Aug. 23–27 Symposium Commemorating the 100th Anniversary of the Mount Krakatau Eruption, Jakarta, Indonesia. Sponsor, Indonesian Institute of Sciences (LIPI). (Committee of the Centennial Krakatau Research Program, LIPI, Gedung PDIN-LIPI, Jalan Gatot Subroto, P.O. Box 250, Jakarta Pusat, Indonesia.)

Aug. 28–Sept. 1 International Symposium on Groundwater in Water Resources Planning, Koblenz, FRG. Sponsor, IAHS. (IHO/OHP Secretariat Bundesanstalt für Gewässerkunde, Postfach 309, D-5400 Koblenz, FRG.)

Aug. 29–Sept. 1 Second International Symposium on Acoustic Remote Sensing of the Atmosphere and Oceans, Rome, Italy. (G. Fiocco or G. Mastrantonio, Istituto di Fisica dell'Atmosfera, P.le Luigi Sturzo, 31, 00144 Rome, Italy.)

Aug. 29–Sept. 1 Oceans '83 Conference, San Francisco, Calif. Sponsors, the Marine Technology Society and the Institute of Electrical and Electronic Engineers Council on Oceanic Engineering. (Oceans '83 Technical Program Chairman, P.O. Box 71080, Sunnyvale, CA 94086.)

Aug. 29–Sept. 3 Fifth International Symposium of the IAMAP Commission on Atmospheric Chemistry and Global Pollution (CACGP), Oxford, UK. (R. Duce, CACGP Secretary, Center for Atmospheric Chemistry Studies, Graduate School of Oceanography, Box 5, Univ. of Rhode Island, Kingston, RI 02881; or P. Goldsmith, Meteorological Office, London Road, Bracknell, Berkshire RG12 2SZ, UK.)

Aug. 29–Sept. 3 4th International Symposium on Water-Rock Interaction, Misasa, Japan. (H. Sakai, Secretary-General, WRI-4, Institute for Thermal Spring Research, Okayama Univ., Misasa, Tottori-Ken 682-02, Japan.)

Aug. 30–Sept. 2 IAMAP–WMO Symposium on Maintenance of the Quasi-Stationary Components of the Flow in the Atmosphere and in the Atmospheric Models, Paris, France. (A. Hollingsworth, European Centre for Medium Range Weather Forecasts, Shinfield Park, Reading, Berks. RG2 9AX, UK, or R. Sadourny, CNRS, Laboratoire de Météorologie Dynamique, Ecole Normale Supérieure, 24, rue Lhomond, 75231, Paris, Cedex 05, France.)

Aug. 31–Sept. 2 International Geoscience and Remote Sensing Symposium (IGARSS '83), San Francisco, Calif. Sponsors, IEEE Geoscience and Remote Sensing Society, URSI, U.S. National Committee, Commission F on Propagation in Non-Ionized Media, AGU. (M. Buettner, Chairman of the Publicity Committee, M.S. L-156, Lawrence Livermore National Laboratory, P.O. Box 5504, Livermore, CA 94550.)

September Symposium on Coastal Geomorphology, Sedimentary Budgets, and Coastal and River Hydraulics, Iceland. Sponsor, Univ. of Iceland. (T. Karlsson, Univ. of Iceland, Reykjavik, Iceland.)

Sept. 2–15 International Symposium on Precambrian Geology, Beijing, China. Sponsors, Geological Society of China, Chinese National Committee for the IGCP, IUGS Commission on Tectonics, IGCP Project No. 92 (Archaean Geochemistry), Working Groups 3 and 4 of the Lithosphere Project. (A. Kröner, Dept. of Geosciences, Univ. of Mainz, P.O. Box 3980, 6500 Mainz, FRG.)

Sept. 5–9 20th International Congress of the International Association of Hydraulic Research (IAHR), Moscow, U.S.S.R. (Organizing Committee, 20th IAHR Congress, Institute "Hydroproject," Volokolamskoe Chaussee 2, Moscow A-80, 125812, USSR.)

Sept. 5–9 Penrose Conference on Blueschists and Related Eclogites, Bellingham and Seattle, Wash. Sponsor, GSA. (E. H. Brown, Dept. of Geology, Western Washington Univ., Bellingham, WA 98225, or B. W. Evans, Dept. of Geological Sciences AJ-20, Univ. of Washington, Seattle, WA 98195.)

Sept. 7–10 AIPG Annual Meeting, Jackson Hole, Wyo. (Gene R. George, General Chairman, P.O. Box 2775, Casper, WY 82602; telephone: 307-265-9199.)

Sept. 12–14 National Water Well Association 35th Annual Convention and Exposition, St. Louis, Mo. (NWWA, 500 West Wilson Bridge Rd., Worthington, OH 43085.)

Sept. 12–16 International Symposium on Isotope Hydrology in Water Resources Development, Vienna, Austria. (IAEA, P.O. Box 100, Vienna International Centre, A-1400, Vienna, Austria.)

Sept. 18–21 Eastern Section Annual Meeting, Mohonk Mountain House, N.Y. Sponsor, Seismological Society of America. (Ellyn Schlesinger-Miller or Noel Barstow, Lamont-Doherty Geological Observatory, Palisades, NY 10964; telephone: 914-359-2900.)

Sept. 18–22 Brecciation and Mineralization Invitational Conference, Colorado Springs, Colo. (Leanne Stone, Division of Continuing Education, Univ. of Nevada-Reno, Reno, NV 89557; telephone: 702-784-4046.)

Sept. 18–23 International Technical Conference on National Weather Service Real-Time Data Collection and Natural Flood Hazards, Sacramento, Calif. Sponsors, WMO, NOAA, California Dept. of Water Resources. (R. J. C. Burnash, California Nevada River Forecast Center, National Weather Service, Room 1641, 1416 Ninth Street, Sacramento, CA 95814 or the Secretary-General, WMO, Case Postale No. 5, CH-1211 Geneva 20, Switzerland.)

Sept. 19–25 International Symposium on the Geology of the Taurus Belt, Ankara, Turkey. Sponsor, Turkey and Geological Institute of Turkey. (Maden Tetkik ve Arama Enstitüsü (MTA), Toros Jeolojisi Uluslararası Sempozyumu Düzenleme Kurulu, Ankara, Turkey.)

Sept. 21–23 Technical Symposium on Acid Rain, Burlington, Vt. (E. A. Cassell, School of Natural Resources, 355 Aiken Center, Univ. of Vermont, Burlington, VT 05405.)

Sept. 25–28 Models in Geomorphology, Buffalo, N.Y. (Michael Woldenberg, Dept. of Geography, State Univ. of New York, Buffalo, NY 14260.)

Sept. 26–30 Second International Meeting on Statistical Climatology, Lisbon, Portugal. Sponsors, National Science Foundation, Office of Naval Research, WMO. (A. H. Murphy, Dept. of Atmospheric Sciences, Oregon State Univ., Corvallis, OR 97331.)

Sept. 30–Oct. 1 AGU Pacific Northwest Regional Meeting, Bellingham, Wash. (David E. Engebretson, Geology Dept., Western Washington State College, Bellingham, WA 98225.)

October Second Iraqi Hydrological Conference, Baghdad. Sponsor, IAHS. ([illegible], Ministry of Irrigation, Baghdad, Iraq.)

Oct. 2–7 Penrose Conference on Cretaceous Climates, Colorado Springs, Colo. Sponsors, GSA and the International Geologic Correlation Program. ([illegible], National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307.)

Oct. 3–7 Chapman Conference on Magnetic Reconnection, Los Alamos, N. Mex. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Oct. 5–13 19th Annual AWRA Conference and Symposium, San Antonio, Tex. ([illegible], 211 E. Sixth Street, Fort Worth, TX 76102.)

Oct. 11–16 Second International Symposium on River Sedimentation, Nanjing, China. ([illegible], Nanjing Hydraulic Research Institute, 223 Guangzhou Road, Nanjing 210024, People's Republic of China.)

Oct. 13–14 The Water Resources of Georgia and Adjacent Areas, Atlanta, Ga. Sponsors, Georgia Geologic Survey, Georgia Institute of Technology. (Bernd Kahn, Environmental Resources Center, Georgia Institute of Technology, Atlanta, GA 30332; telephone: 404-894-3776, or Ram Arora, Georgia Geologic Survey, 19 M. L. King Jr. Dr. S.W., Atlanta, GA 30334; telephone: 404-656-3214.)

Oct. 16–20 Fifth International Conference on Basement Tectonics, Cairo, Egypt. Sponsor, Denver-based Basement Tectonics Committee, Inc. (J. Gallagher, Jr., Cities Service Co., Box [illegible], Tulsa, OK 74102, or [illegible], Dept. of Geology, Univ. of Assiut, Assiut, Egypt.)

Oct. 17–20 15th Annual Meeting of the Division of Planetary Sciences, American Astronomical Society, Ithaca, N.Y. (Steven J. Ostro, Space Sciences Building, Cornell Univ., Ithaca, NY 14853.)

Oct. 17–21 Technical Conference on Observation and Measurement of Atmospheric Contamination, Vienna, Austria. Sponsors, WMO, International Atomic Energy Agency, UNEP, and the Austrian Zentralanstalt für Meteorologie und Geodynamik. (WMO Secretariat, Attention: CFSV, Case postale No. 5, CH-1211 Geneva 20, Switzerland.)

Oct. 18–20 International Lake and Reservoir Management Symposium, Knoxville, Tenn. Sponsor, North American Lake Management Society. (Lowell Klessig, College of Natural Resources, Univ. of Wisconsin, Stevens Point, WI 54481; telephone: 715-346-3783. For additional information, [illegible], Tennessee Valley Authority, 248 401 Building, Chattanooga, TN 37401; telephone: 615-751-7333.)

Oct. 31–Nov. 2 Shuttle Environment and Operations, Washington, D.C. Sponsor, American Institute of Aeronautics and Astronautics. (AIAA, Meetings Dept., 1290 Avenue of the Americas, New York, NY 10019.)

Oct. 31–Nov. 2 Sixth Oak Ridge National Laboratory Life Sciences Symposium, Knoxville, Tenn. Sponsors, U.S. Dept. of Energy, [illegible], the National Science Foundation, the National Oceanic and Atmospheric Administration, the Electric Power Research Institute, and Gas Research Institute. (Debbie Shepherd, Oak Ridge National Laboratory, P.O. Box X, Building 1505, Oak Ridge, TN 37830; telephone: 615-574-7320.)

Oct. 31–Nov. 3 GSA Annual Meeting, Indianapolis, Ind. (J. M. Latulippe, Meetings Dept., GSA, P.O. Box 9140, Boulder, CO 80301.)

Oct. 31–Nov. 4 American Institute of Chemical Engineers, Washington, D.C. (R. Peters, Civil Engineering, Purdue Univ., West Lafayette, IN 47907.)

Nov. 7–8 14th Underwater Mining Institute Meeting, Madison, Wis. (J. R. Moore, Marine Science Institute, Univ. of Texas–Austin, 700 East St., Austin, TX 78705; telephone: 512-471-[illegible].)

Nov. 14–17 Seventh International Symposium on the Scientific Basis for Nuclear Waste Management, Boston, Mass. Sponsor, Materials Research Society. (Gary L. McVay, Materials Dept., Battelle Northwest Laboratories, P.O. Box 999, Richland, WA 99352; telephone: 509-375-3762.)

Nov. 16–18 Eighth Conference on Probability and Statistics in Atmospheric Sciences, Hot Springs, Ark. Sponsor, AMS. (R. W. Katz, Dept. of Atmospheric Sciences, Oregon State Univ., Corvallis, OR 97331.)

Nov. 16–18 Third Applied Climatology Conference, Hot Springs, Ark. Sponsors, Committee on Applied Statistics and Applied Climatology of AMS. (Send all abstracts to Wayne M. Wendland, Illinois State Water Survey, P.O. Box 5050, Station A, Champaign, IL 61820.)

Dec. 5–10 AGU Fall Meeting, San Francisco, Calif. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Dec. 12–13 Conference on Advances in Infiltration, Chicago, Ill. Sponsors, American Society of Agricultural Engineers, AGU. (J. L. Nieber, Program Chairman, Dept. of Agricultural Engineering, Texas A&M Univ., College Station, TX 77843.)

1984

Jan. 9–13, 1984 Chapman Conference on Natural Variations in Carbon Dioxide and the Carbon Cycle, Tarpon Springs, Fla. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Jan. 16–20 Microwave Signatures in Remote Sensing, Toulouse, France. Sponsors, Centre National d'Etude Spatiales with the participation of URSI Commission F and the Centre d'Etude Spatiale des Rayonnements (CESR). (Technical program, Erwin Schanda, Universität Bern, Institut of Applied Physics, Sidlerstrasse 5, 3012 Berne, Switzerland or Richard K. Moore, Remote Sensing Laboratory, Univ. of Kansas Center for Research, Inc., 2291 Irving Hill Drive-Campus West, Lawrence, KS 66045. Registration, F. Cambou, Head, CESR, 9 Avenue du Colonel Roche, B.P. 4346, 31029 Toulouse-Cedex, France.)

Jan. 23–27 Ocean Sciences Meeting, New Orleans, La. (John R. Apel, Assistant Director for Planning, Johns Hopkins Univ., Applied Physics Laboratory, Johns Hopkins Rd., Laurel, MD 20707.)

Feb. 9–14 International Symposium on Recent Crustal Movements of the Pacific Region, Wellington, New Zealand. Sponsor, Royal Society of New Zealand. (Secretary, H. M. Bibby, Geophysics Division, DSIR, P.O. Box 1320, Wellington, New Zealand.)

Feb. 20–24 Chapman Conference on Collisionless Shock Waves in the Heliosphere, Napa, Calif. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

March 11–16 American Congress on Surveying and Mapping National Meeting, Washington, D.C. ([illegible], 4415 Jensen Pl., Fairfax, VA 22032; telephone: 202-425-6790.)

March 19–24 Third International Symposium on Land Subsidence, Venice, Italy. Sponsor, IAHS. (A. I. Johnson, Program Chairman, Third International Symposium on Land Subsidence, Woodward-Clyde Consultants, 7600 East Orchard Rd., Englewood, CO 80111.)

March 26–30 7th International Symposium on Equatorial Aeronomy (ISEA), Hong Kong. Sponsors, [illegible]. (ISEA, High Altitude Observatory, NCAR, P.O. Box 3000, Boulder, CO 80307; telephone: 303-494-5151.)

March 26–27 South-Central Section Meeting of the GSA, Dallas, Tex. (Jean Latulippe, Meetings Dept., GSA, Boulder, CO 80301; telephone: 303-447-2020.)

April International Conference on Recent Advances in [illegible], South Africa. [illegible]

April 16 [illegible] North-Central Section Meeting of the GSA [illegible]

May 14–18 AGU Spring Meeting, Cincinnati, Ohio. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

May 21–23 International Groundwater Symposium on Groundwater Resources Utilization and Contaminant Hydrogeology, Montreal, Quebec, Canada. Sponsors, Canadian National Chapter of the International Association of Hydrogeologists, and the Canadian Water Resources Association. (A. Kohut, Chairman, International Groundwater Symposium, Ministry of the Environment, 765 Broughton St., Victoria, British Columbia, Canada V8V 1X5.)

May 21–26 Symposium on the History of Soil and Water Conservation, Columbia, Mo. Sponsors, Missouri Cultural Heritage Center at the Univ. of Missouri, the Agricultural History Society, and the Soil Conservation Service of the U.S. Dept. of Agriculture. (Susan Flader, Dept. of History, Univ. of Missouri, Columbia, MO 65211; telephone: 314-882-2481 or 314-[illegible], or Douglas Helms, Historian, Soil Conservation Service, P.O. Box 2890, Washington, DC 20013; telephone: 202-382-[illegible].)

May 29–June 1 Joint Meeting of the 18th Annual Congress of the Canadian Meteorological and Oceanographic Society and the Canadian Geophysical Union, Halifax, Nova Scotia, Canada. (Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia B2Y 4A2.)

Summer Summer Computer Simulation Conference, Boston, Mass. Sponsor, Society for Computer Simulation. (SCS, P.O. Box 2228, La Jolla, CA 92038.)

June International Symposium on Impermeable Barriers, Denver, Colo. (A. I. Johnson, Impermeable Barriers, Woodward-Clyde Consultants, 7600 E. Orchard Rd., Englewood, CO 80111.)

June 25–27 Rock Mechanics in Productivity and Protection, 25th U.S. Symposium on Rock Mechanics, Evanston, Ill. (Charles H. Dowding, Dept. of Civil Engineering, Northwestern Univ., Evanston, IL 60201; telephone: 312-492-7270.)

June 25–27 Symposium on the Achievements of the International Magnetospheric Study, Graz, Austria. Sponsor, Scientific Committee on Solar-Terrestrial Physics of ICSU. (J. G. Roederer, Geophysical Institute, Univ. of Alaska, Fairbanks, AK 99701.)

June 26–28 International Symposium on Deep Structure of the Continental Crust: Results from Reflection Seismology, Ithaca, N.Y. (Jack Oliver, Program Chairman, Dept. of Geological Sciences, Cornell Univ., Ithaca, NY 14853; telephone: 607-256-[illegible] or Telex [illegible].)

July 21–28 Eighth World Conference on Earthquake Engineering, San Francisco, Calif. Sponsor, Earthquake Engineering Research Institute. (EERI, 2620 Telegraph Avenue, Berkeley, CA 94704.)

July 24–26 Water Rights Specialty Conference, Flagstaff, Ariz. Sponsors, Ground Water Committee and Surface Water Committee of the Irrigation and Drainage Division of the ASCE. (Symposium contact, Kenneth G. Renard, Southwest Watershed Research Center, 2000 E. Allen Road, Tucson, AZ 85719; telephone: 602-629-6381.)

July 31–Aug. 2 Fourth International Symposium on Stochastic Hydraulics, Univ. of Illinois, Urbana, Ill. Sponsor, International Association for Hydraulic Research and ASCE. (Ben Chie Yen, Wilson H. Tang, or Glenn E. Stout, Dept. of Civil Engineering, Univ. of Illinois, 208 N. Romine St., Urbana, IL 61801; telephone: 217-333-0687 or 333-[illegible].)

Aug. 4–14 27th International Geological Congress, Moscow, USSR. Sponsor, USSR National Committee for Geology, IUGS. (Organizing Committee of the 27th IGC, Institute of the Lithosphere, 22, Staromonetny per., 109180, USSR.)

Aug. 12–16 20th Annual AWRA Conference and Symposium, Washington, D.C. ([illegible], Corps of Engineers, Institute for Water Resources, Kingman Bldg., Fort Belvoir, VA 22060.)

Aug. 21–29 International Radiation Symposium '84 (IRS), Perugia, Italy. Sponsor, Radiation Commission of IAMAP. (Giorgio Fiocco, Chairman, IRS '84, Dipartimento di Fisica, Città Universitaria, 00185 Rome, Italy; Telex: INFNRO 613255.)

Sept. 3–7 Quadrennial Ozone Symposium, Halkidiki, Greece. Sponsors, International Ozone Commission of IAMAP, Commission of the European Communities, the Academy of Athens, and the WMO. (Christos S. Zerefos, Chairman, Local Organizing Committee, Physics Dept., Campus Box 149, Univ. of Thessaloniki, Thessaloniki, Greece. Send copy of information request to C. D. Walshaw, Secretary, International Ozone Commission, Clarendon Laboratory, Oxford Univ., Parks Road, Oxford, OX1 3PU, UK.)

Oct. 17–19 AIPG Annual Meeting, Orlando, Fla. (Bobby J. Timmons, General Chairman, Timmons Associates, P.O. Box [illegible], Jacksonville, FL [illegible]; telephone: 904-[illegible].)

Nov. 5–8 GSA Annual Meeting, Reno, Nev. (Jean Latulippe, GSA, P.O. Box 9140, Boulder, CO 80301; telephone: 303-447-2020.)

1985

January International Congress of the International Association of Hydrogeologists (IAH), Tucson, Ariz. Sponsors, IAH, AGU, GSA, [illegible]. ([illegible], Chairman of the Arrangements Committee, Dept. of Hydrology and Water Resources, Univ. of Arizona, Tucson, AZ 85721.)

March 10–15 American Congress on Surveying and Mapping National Meeting, Washington, D.C. ([illegible], 4415 Jensen Pl., Fairfax, VA 22032; telephone: 202-425-6790.)

May 27–31 AGU Spring Meeting, Baltimore, Md. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Aug. 5–16 IAMAP/IAPSO Joint Assembly, Honolulu, Hawaii. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Aug. 19–23 Sixth Gondwana Symposium, Columbus, Ohio. Sponsor, GSA. (D. Elliot, Institute of Polar Studies, Ohio State Univ., 125 South Oval Mall, Columbus, OH 43210; telephone: 614-422-[illegible].)

Sept. 17–21 AIPG Annual Meeting, Denver, Colo. ([illegible], General Chairman, [illegible] Oakcrest Avenue, Roseville, MN [illegible]; telephone: 612-636-[illegible].)

Oct. 14–17, 1985 GSA Annual Meeting, Orlando, Fla. (Jean Latulippe, GSA, P.O. Box 9140, Boulder, CO 80301; telephone: 303-447-2020.)

Future AGU Meetings

Spring Meetings
May 14–18, 1984, Cincinnati
May 27–31, 1985, Baltimore

Fall Meetings
Dec. 5–10, 1983, San Francisco

Abbreviations

AAAS American Association for the Advancement of Science
AAPG American Association of Petroleum Geologists
ACS American Chemical Society
AIPG American Institute of Professional Geologists
AMS American Meteorological Society
ASCE American Society of Civil Engineers
AWRA American Water Resources Association
GSA Geological Society of America
IAG International Association of Geodesy
IAGA International Association of Geomagnetism and Aeronomy
IAHS International Association for Hydrological Sciences
IAMAP International Association of Meteorology and Atmospheric Physics
IAPSO International Association of Physical Sciences of the Ocean
IASPEI International Association of Seismology and Physics of the Earth's Interior
IAVCEI International Association of Volcanology and Chemistry of the Earth's Interior
ICSU International Council of Scientific Unions
IUGG International Union of Geodesy and Geophysics
IUGS International Union of Geological Sciences
IWRA International Water Resources Association
MSA Mineralogical Society of America
SEG Society of Exploration Geophysicists
SEPM Society of Economic Paleontologists and Mineralogists
URSI International Union of Radio Science
WMO World Meteorological Organization

GAP

Separates

To Order: The order number can be found at the end of each abstract; use all digits when ordering. Only papers with order numbers are available from AGU. *Cost:* $3.50 for the first article and $1.00 for each additional article in the same order. Payment must accompany order. Deposit accounts available.

Send your order to:
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

Aeronomy

0419 Absorption and Scattering of Radiation
ATTENUATION OF SOLAR IRRADIANCE IN THE STRATOSPHERE: SPECTROMETER MEASUREMENTS BETWEEN 191 AND 207 NM
G.P. Anderson and L.A. Hall (Air Force Geophysical Laboratory, Bedford, MA 01731)
Measurements made by a balloon-borne, single dispersion spectrometer have been used to investigate the attenuation of solar irradiance in the wavelength region of the O_2 Schumann-Runge bands and the Herzberg continuum. The data cover the altitude range from 28 to 39 km. The fine spectral resolution (.012 nm) allows transmittance windows in the Schumann-Runge spectra to be resolved, facilitating the comparison of their characteristic absorption to model calculations. An atmospherically derived O_2 cross section developed in this analysis is significantly lower than the Herzberg continuum values most used in photochemical models. (Solar ultraviolet irradiance, stratosphere, O_2 absorption cross sections, balloon).
J. Geophys. Res., Green, Paper [illegible]

0430 Composition (atomic or molecular)
THE RESPONSE OF THERMOSPHERIC ATOMIC NITROGEN TO MAGNETIC STORMS
H. J. Engebretson (Department of Physics, Augsburg College, Minneapolis, MN 55454) and [illegible] Mauersberger
Neutral composition data obtained by the open source neutral mass spectrometer (OSS) on the polar orbiting Atmosphere Explorer-D satellite during the period October 31 – November 15, 1975 and January 5 – 15, 1976 are used to characterize the response of thermospheric atomic nitrogen densities to geomagnetic activity. These periods provided nearly simultaneous polar and low latitude data coverage. At low and mid-latitudes near dawn and at all latitudes on the dayside N densities at 400 km appear to vary like those of a species of atomic mass 14; N is observed to increase with increasing geomagnetic activity in a manner similar to that of N_2. At auroral latitudes near dawn, however, there is a more complex dependence on the amplitude of the disturbance. For substorm-scale activity N tends to increase during periods of auroral heating but exhibits a sharp temporary decrease afterward. During large storms there is a significant but short-lived increase of N at auroral latitudes. Our results support current models showing that N is produced and transported out of the auroral zone during geomagnetic disturbances.
J. Geophys. Res., Blue, Paper 3A0755

0440 Convection, diffusion, mixing, turbulence, and fallout
TURBULENCE ORIGINATING FROM CONVECTIVELY STABLE INTERNAL WAVES
[illegible] Lindzen (Center for Earth and Planetary Physics, Harvard University, Cambridge, Massachusetts, 02138) and J. Forbes
A theory has recently been developed for the generation of turbulence by unstable tidal and gravity waves (Lindzen, 1981). Central from this theory was consideration of the possibility that turbulence could be generated by gravity waves which were not convectively unstable (i.e., breaking). The possibility of such generation was suggested by a result of McComas and Bretherton (1976) showing that internal gravity waves are indeed unstable to other gravity waves with shorter wavelengths. The present paper estimates the maximum turbulence which might be generated by such a process and shows that even this turbulence would not greatly alter earlier results. (Gravity waves, cascade, upper atmosphere turbulence).
J. Geophys. Res., Green, Paper 3C0624

Geochemistry

1110 Chemistry of the atmosphere
RELATIONSHIPS BETWEEN Pb and Pb-210 IN AEROSOL AND PRECIPITATION AT A SEMI-REMOTE SITE IN NORTHERN WISCONSIN (U.S.A.)
R. W. Talbot (Environmental Systems Engineering, Clemson University, Clemson, South Carolina 29631) and A. W. Andren
Measurements of Al, Pb, Pb-210, and Po-210 in precipitation and aerosol were used to estimate wet and dry components of the atmospheric flux. Wet deposition dominated the removal of airborne Pb, Pb-210, and Po-210 while dry deposition was also important for Al. The behavior of Pb-210 in the atmosphere appeared to mimic that of Pb based on the constancy of aerosol specific activity (Pb-210/Pb) and the nearly identical fluctuations of lead/Al ratios as a function of time. However, precipitation washout ratios for Pb and Pb-210 suggest that Pb-210 was washed from the atmosphere with greater efficiency than Pb. Slight differences in aerosol mass-size relationships for Pb and Pb-210 may be responsible for the unequal precipitation washout efficiencies. By correcting for the apparent differential precipitation washout of Pb and Pb-210, a reasonable estimate of the atmospheric flux of Pb was obtained using the mean Pb/Pb-210 ratio in aerosol and the Pb-210 flux. The atmospheric flux to northern Wisconsin was estimated to be 0.8 ng cm^{-2} yr^{-1} for Pb and 0.70 pCi cm^{-2} yr^{-1} for Pb-210. (Atmospheric flux, precipitation washout, particle size effects).
J. Geophys. Res., Green, Paper 3C0546

Hydrology

3130 Groundwater
FINITE ELEMENT TECHNIQUES FOR MODELING GROUNDWATER FLOW IN FRACTURED AQUIFERS
P.S. Huyakorn, B.H. Lester, and C.R. Faust (GeoTrans, Inc., P.O. Box 2550, Reston, VA 22090)
A mathematical description of ground-water flow in fractured aquifers is presented. Four alternative conceptual models are considered. The first three are based on the dual-porosity approach with different representations of fluid interactions between the fractures and porous matrix blocks, and the fourth is based on the discrete fracture approach. Two numerical solution techniques are presented for solving the governing equations associated with the dual-porosity flow models. In the first technique, the Galerkin finite element method is used to approximate the equation of flow in the fracture domain, and a convolution integral is used to describe the leakage flux between the fractures and porous matrix blocks. In the second, the Galerkin finite element approximation is used in conjunction with a one-dimensional finite difference approximation to handle flow in the fractures and matrix blocks, respectively. Both numerical techniques are shown to be readily amendable to the governing equations of the discrete fracture flow model. To verify the proposed numerical techniques and compare various conceptual models, four simulations of a problem involving flow to a well fully penetrating a fractured confined aquifer were performed. Each simulation corresponded to one of the four conceptual models. For three of the simulated cases, where analytical solutions are available, the numerical and the analytical solutions were compared. It was found that both solution techniques yielded good results with relatively coarse spatial and temporal discretizations. Greater accuracy was achieved by the combined finite element-convolution integral technique for early time values at which steep hydraulic gradients occurring near the fracture-matrix interface could not be accommodated by the linear finite difference approximation. Finally, the results obtained from the four simulations are compared, and a discussion is presented on practical implications of these results and the utility of various flow models. (Finite element method, fractured media, flow simulation).
Water Resour. Res., Paper 3W0586

[illegible] General or Miscellaneous
A NEW DERIVATION OF THE TAYLOR-ARIS THEORY OF SOLUTE DISPERSION IN A CAPILLARY
[illegible] Gupta (Dept. of Civil Eng., Univ. of [illegible]) and R. N. Bhattacharya
The transport of a dilute solute under Stokes motion in a straight capillary is described at three distinct space time scales. These are the kinetic, fluid mechanical and Taylorian scales. The transition from one scale to the next higher is shown to be a consequence of the central limit theorem of probability theory. The Taylor Aris dispersion equation is derived by an application of a recently proved CLT for Markov processes. An alternative computation of the dispersion coefficient is given using a "differential equation averaging" approach. A third method, which also applies to solute transport in porous media, is illustrated for an approximate computation of the dispersion coefficient. (Scales, Markov process, central limit theorem, Taylor, Planck equation).
Water Resour. Res., Paper 3W0581

Meteorology

3750 Clouds (Atmospheric Water)
R.G. Pinnick (US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM, 88002), S.G. Jennings, Petr Chýlek, Chris Ham, W.T. Grandy, Jr.
An approximate relation between the volume extinction coefficient σ_e and backscatter coefficient σ_b of atmospheric cloud at visible and infrared wavelengths is derived using complex-angular-momentum theory. To zero order the relation is linear and independent of the droplet size distribution

$$\sigma_e = \frac{8\pi}{g(\lambda)}\,\sigma_b$$

where $g(\lambda)$ is a slowly varying function of wavelength. Predictions made with this relation are in good agreement with extinction and backscatter measurements made on laboratory-generated fog droplet distributions. The relation suggests that visible or near-infrared extinction coefficients in cloud of unknown type could be inferred from lidar backscatter measurements alone, without knowledge of the cloud droplet size spectra, barring complications arising from multiple scattering contributions to the lidar return. (Clouds, lidar, backscattering, extinction).
J. Geophys. Res., Green, Paper 3C0673

3750 H_2O in the Atmosphere
A DYNAMIC MODEL FOR THE PRODUCTION OF H^+, NO_3^- AND SO_4^{2-} IN URBAN FOG
D. J. Jacob and M. R. Hoffmann (Keck Engineering Laboratories, California Institute of Technology, Pasadena, California, 91125)
The chemical composition of nighttime urban fog has been investigated using a hybrid kinetic and equilibrium model. Extremely high acidity may be imparted to the droplets by condensation and growth on acidic condensation nuclei or by *in situ* S(IV) oxidation. Important oxidants of S(IV) were found to be O_2 as catalyzed by Fe(III) and Mn(II), H_2O_2 and O_3. Formation of hydroxymethanesulfonate ion (HMSA) via the nucleophilic addition of HSO_3^- to $CH_2(OH)_2$ significantly increased the droplet capacity for S(IV) but did not slow down the net S(IV) oxidation rate leading to fog acidification. Gas phase nitric acid, ammonia and hydrogen peroxide were scavenged efficiently, although aqueous phase hydrogen peroxide was depleted rapidly by reaction with S(IV). Nitrate production in the aqueous phase was found to be dominated by HNO_3 gas phase scavenging. Major aqueous-phase species concentrations were controlled primarily by condensation, evaporation, and pH. (Fog, acidity, S(IV) oxidation, scavenging).
J. Geophys. Res., Green, Paper 3C0722

Particles and Fields—Interplanetary Space

5340 Shock Waves
COUPLED HYDROMAGNETIC WAVE EXCITATION AND ION ACCELERATION AT INTERPLANETARY TRAVELLING SHOCKS
M. A. Lee (Space Science Center, Physics Department, University of New Hampshire, Durham, NH 03824)
A self-consistent theory is presented for the excitation of hydromagnetic waves and the acceleration of ions upstream of interplanetary travelling shocks. The waves are excited by the ions by virtue of ion streaming relative to the solar wind; the ions are accelerated by being coupled to the compression of the shock via pitch-angle scattering on the upstream waves and the downstream turbulence. Diffusion equations describing the ion transport and wave kinetic equations describing the hydromagnetic wave transport are solved self-consistently to yield analytical expressions for the differential wave intensity spectrum as a function of wavenumber k and distance z upstream of the shock and for the ion omnidirectional distribution functions and anisotropies as functions of energy E and z. In quantitative agreement with observations the theory predicts, for example, (a) power law ion spectra at the shock $\propto E^{-\Gamma}$ with $2 \lesssim \Gamma \lesssim 3$, (b) a decrease in intensity and hardening of the ion spectra with increasing z, (c) upstream ion anisotropies (~0.1 for 30 keV protons) away from the shock front in the frame of the solar wind, (d) an unpolarized enhanced wave intensity spectrum in the wavenumber range corresponding to $0.4\text{–}3\times10^{-2}$ Hz in the spacecraft frame, and (e) a decrease in the wave intensity spectrum with increasing z. (Ion shock acceleration, ULF wave excitation, foreshock structure).
J. Geophys. Res., Blue, Paper 3A0655

5370 Solar Wind Magnetic Fields
REMOVAL OF VELOCITY BIAS IN THE INTERPRETATION OF MEASUREMENTS OF THE AZIMUTHAL COMPONENT OF THE INTERPLANETARY MAGNETIC FIELD
M. Eyni and R. Steinitz (Physics Department, Ben-Gurion University, 84105 Beer Sheva, Israel)
Parker's model for the interplanetary magnetic field predicts an r^{-1} dependence for the azimuthal component. Departures from this relation were indicated in an analysis of a subset of the Helios 1 data. As in a previous analysis of Pioneer 10 data, these departures can be traced to velocity bias. We examine the decrease in solar wind speed which occurred as Helios 1 approached the sun, and thus simulated a steeper gradient of the azimuthal magnetic field component. A simple linear fit between flow speed and distance from the sun enables us to remove from the data most of the velocity bias present. This procedure substantially improves the agreement between Parker's model and the Helios data. (Velocity bias, azimuthal interplanetary magnetic field, Archimedean spiral).
J. Geophys. Res., Blue, Paper 3A0720

Particles and Fields—Ionosphere

5515 Auroras (diffuse)
ARE EQUATORIAL ELECTRON CYCLOTRON WAVES RESPONSIBLE FOR DIFFUSE AURORAL ELECTRON PRECIPITATION?
G. Belmont (CNET/Centre de Recherches en Physique de l'Environnement Terrestre et Planétaire, 92131 Issy-les-Moulineaux, France), D. Fontaine, P. Canu
On the basis of theoretical calculations of electron diffusion coefficients and of OGO-5 data, Lyons (1974) suggested that electrostatic electron cyclotron harmonic waves had amplitudes large enough to cause the strong pitch-angle diffusion of plasmasheet keV electrons and to be responsible for diffuse auroral precipitation. However, recent measurements of the wave location and amplitude performed aboard the GEOS spacecraft have brought new pieces of information challenging these conclusions. Our calculations are based on the theoretical tool developed by Lyons (1974) but take into account the recently observed wave confinement within a few degrees from the magnetic equator. Under these conditions, we avoid the numerical averaging of the pitch-angle diffusion coefficient over the whole line of force and we can derive an analytical expression of the minimum wave amplitude required to cause strong pitch-angle diffusion for plasmasheet electrons. This expression has the advantage to be easily tractable in further calculations, and permits us to evaluate the dependence of the results on parameters which are not reported by observations, such as the wave number spectrum. Our results are found to differ from Lyons (1974)'s predictions by a factor of about 2.5, and typically, a wave amplitude of more than 2 mV.m^{-1} is required to put one- keV electrons on strong diffusion. On another hand, on the basis of a statistical analysis of electron cyclotron wave amplitudes measured in the nightside plasmasheet by the GEOS-2 spacecraft, we show that most of the time (~91 %), this typical value of 2 mV.m^{-1} is not reached. This result appears inconsistent with the hypothesis that diffuse auroras, which are a permanent feature of the auroral zones, are due solely to electrostatic electron cyclotron waves. This leads us to the conclusion that these waves are not the only cause of diffuse electron precipitation. It is suggested that other mechanisms involving for instance the dynamics of the ions (such as field-aligned currents) could play an important role. (Diffuse auroras, electrostatic waves, pitch-angle diffusion).
J. Geophys. Res., Blue, Paper 3A0719

5563 Plasma motion, convection, or circulation
LARGE-SCALE COUNTERSTREAMING OF H^+ AND He^+ ALONG PLASMASPHERIC FLUX TUBES
P. G. Richards (Center for Atmospheric and Space Sciences, Utah State University, Logan, Utah 84322), [illegible]
An interhemispheric plasma transport model has been used to study the flow characteristics of H^+, He^+ and O^+ along closed geomagnetic field lines for solstice conditions at noon local time. The calculations were carried out for the flux tube that passes through Millstone Hill. Both symmetric and asymmetric neutral winds in the conjugate ionospheres were considered. Initially, the flux tube content was partially depleted and the subsequent refilling was studied until a steady state flow was established between the winter and summer hemispheres. The main conclusion to be drawn from this study is that H^+ – He^+ counterstreaming can be expected along a large segment of a plasmaspheric flux tube at solstice. For both symmetric and asymmetric wind patterns, the He^+ flow is from the winter to the summer ionosphere not only in the steady state, but during flux tube refilling owing to the winter helium bulge and the depletion of N_2. For symmetric poleward neutral winds in both hemispheres, H^+ and O^+ flow up from the conjugate ionospheres during flux tube refilling, which leads to large-scale H^+ – He^+ counterstreaming in the summer hemisphere. In the steady state, both H^+ and He^+ flow from the winter to the summer ionosphere and no light-ion counterstreaming occurs. When the neutral wind in the summer hemisphere is set to zero, which acts to reduce the F-region "winter anomaly", H^+ – He^+ counterstreaming occurs in the summer hemisphere during refilling and along the entire flux tube in the steady state. The H^+ – He^+ counterstreaming velocities obtained are too small to excite plasma instabilities, but large enough to be measured.
J. Geophys. Res., Blue, Paper 3A0757

Particles and Fields—Magnetosphere

5739 Magnetopause
COMMENTS ON "THE CAUSES OF CONVECTION IN THE EARTH'S MAGNETOSPHERE: A REVIEW OF DEVELOPMENTS DURING THE I.M.S." BY S.W.H. COWLEY
M.J. Heikkila (Center for Space Sciences, The University of Texas at Dallas, Box 688, Richardson, Texas 75080).
We must be concerned with the topology of the electric field as well as of the magnetic field in deducing what physical processes are operative and important in the magnetosphere. Most theories of reconnection are based on a constant electric field, whereas a field with a finite curl is required to draw energy stored in the magnetic field. Cowley's conclusion that the "ISEE results provide overwhelming in situ evidence for the occurrence of reconnection at the dayside magnetopause" is based on a comparison with standard reconnection theories only, involving curl E = 0; therefore, his conclusion is unwarranted. (Magnetopause, electric fields, interactions between solar wind and the magnetosphere).
Rev. Geophys. Space Phys., Paper 3R0727

5763 Plasmapause
SOME ASPECTS OF PLASMAPAUSE PROBING BY WHISTLERS
D. L. Carpenter (Space, Telecommunications and Radioscience Lab, Stanford University, Stanford, CA 94305)
A guide to the whistler literature is presented, with emphasis on whistler probing of plasma structure and motions near the plasmapause. Whistler probing experiments have identified several types of variations in plasmasphere radius with local time, including: 1) variations of a few tenths of an R_E over ~20° longitude that appear to originate on the nightside of the earth during substorms; 2) a secondary maximum in plasmasphere radius near noon; 3) the dusk-side plasmasphere bulge. A variety of remarkable and as yet incompletely understood VLF propagation effects occur in the vicinity of the plasmapause, including a decrease in received whistler activity outside the boundary and unusual propagation features such as echoing above the half-equatorial gyrofrequency on paths just outside the plasmapause. Whistlers provide important information on magnetospheric conditions during wave-particle interaction periods, for example, on equatorial electron densities and path magnetic shell parameters needed in modeling studies of observed interactions. (Thermal plasma structure, plasmapause radius variations, propagation anomalies).
Rad. Sci., Paper 3R0758

Physical Properties of Rocks

6110 Physical Properties of Rocks
THE EFFECTS OF AQUEOUS CHEMICAL ENVIRONMENTS ON CRACK AND HYDRAULIC FRACTURE PROPAGATION AND MORPHOLOGIES
J. D. Dunning (Department of Geology, Indiana University, Bloomington, Indiana 47405), W. L. Huf
The role of surface active aqueous environments in chemomechanical weakening of geologic materials is examined in light of the results of hydraulic fracture tests in sandstone, calorimetric studies, and crack propagation tests in synthetic quartz. In hydraulic fracture tests employing Crab Orchard Sandstone it was found that the effective hydraulic fracture pressure was reduced, over that attained with distilled water, when 5×10^{-4} M aqueous solutions of dodecyl trimethyl ammonium bromide (DTAB), were used as the hydraulic fracture medium. The degree of branching of the fractures was also increased in the presence of the DTAB solution. Previously reported crack propagation stress values in quartz exposed to distilled water and various DTAB solutions displayed the same trend. When examined in this study, the cracks propagated in the presence of DTAB solutions also displayed a greater degree of branching than those propagated in the presence of distilled water or the ambient atmosphere. These results and results from calorimetric measurements of the heats of adsorption on and desorption from quartz of distilled water and DTAB are synthesized in a model relating the weakening and morphological effects to a reduction in the surface free energy of quartz due to adsorption of species from the chemical environment onto the surfaces of the quartz and sandstone.
J. Geophys. Res., Red, Paper 3B0677

Tectonophysics

8110 Convection Currents
CONVECTION IN A TWO-LAYER MANTLE WITH A STRONGLY TEMPERATURE – DEPENDENT VISCOSITY
P.M. Kenyon (Department of Geological Sciences, Cornell University, Ithaca, NY 14853) and D.L. Turcotte
Recent geochemical and isotopic data support the hypothesis that the earth's mantle convects in two separate layers with an interface at the 650 km seismic discontinuity. This paper studies the implications of this hypothesis with regard to the thermal boundary layers that are expected to develop adjacent to the interface between the convecting layers. We are particularly concerned with a possible decrease in the mantle viscosity across this interface. In order to study the structure of the thermal boundary layers in a fluid with a strongly temperature-dependent viscosity we utilize an approximate method developed by Howard. If the upper and lower mantle have the same viscosity law, we find that stratified convection requires a lower mantle viscosity which is several orders of magnitude lower than the upper mantle viscosity. This is not consistent with studies of postglacial rebound. It is possible to obtain a viscosity law for the lower mantle that gives a viscosity nearly equal to that of the upper mantle and reasonable temperatures. However, the required law is not consistent with the currently available experimental data on lower mantle materials. Therefore, we conclude that thermal arguments favor whole mantle convection. (Mantle convection, temperature, viscosity)
J. Geophys. Res., Red, Paper [illegible]

8150 Plate Tectonics
SPECULATIONS ON THE MESOZOIC PLATE TECTONIC EVOLUTION OF EASTERN CHINA
Michael P. Klimetz (Department of Geological Sciences, State University of New York at Albany, Albany, New York 12222)
Several orogenic belts transecting eastern China are the sites of former convergent plate margins, although there have been varying views on the collisional framework of individual continental blocks, styles of convergence at these zones, and the timing of respective collisions. A tectonic study of eastern China, Mongolia and the southern Soviet Far East indicates the collision of the South China Block with a combined North China-Northeast China Fold Zone Block in the Late Triassic-Early Jurassic, their collective suturing to Eurasia in the Late Jurassic-Early Cretaceous, followed by the Sikhote Alin-Japan Block in the Mid to Late Cretaceous. The evidence is as follows: (1) A linear belt of Late Triassic-Early Cretaceous granites and granodiorites trends east from the Qinlingshan through the Dabieshan to the Huaiyang massif. Ophiolites, flysch, subduction zone mélange, a paired metamorphic belt indicating north dipping subduction and marine strata of Carboniferous to Late Triassic age from the Qinlingshan define the suture between the North and South China Blocks, (2) A sinuous belt of ultramafics, blueschists, silicic to intermediate magmatism and west and north vergent folds and thrusts trend from the west margin of the Ordos Basin through central Inner Mongolia and along the east Great Khingan Range to the Amur River. Coupled with a Mid Jurassic-Early Cretaceous unconformity a suturing of eastern Chinese blocks to Eurasia along this zone is suggested, (3) A fold and thrust belt with ultramafics, flysch, blueschists and subduction zone mélange along the Ussuri River in northeast China indicates the suturing of the Sikhote Alin-Japan Block to Eurasia along a west dipping subduction zone in the Mid to Late Cretaceous. Similarly, a tectonic study of southern China and Southeast Asia has revealed a complex regional mosaic of suture-bounded terrains which nucleated about the eastern, western and southern margins of the Yangtze Craton during the Late Triassic and Early Jurassic. The evidence is as follows: (4) A north-south trending belt of ophiolites, blueschists, calc-alkaline volcanics and subduction zone mélange, including granites, granodiorites and strongly deformed marine strata all of Late Triassic age exposed in the Longmenshan of Sichuan merge with the Ketaxtlieshan ophiolite zone into the Ailaoshan-Tengtiaohe ophiolite and blueschist belt in central Yunnan along which the Songban-Ganzi Complex and the Shan-Thai-Malaya Block join the Craton, and (5) A southeastern prolongation of the Ailaoshan-Tengtiaohe belt bifurcates into the southeast trending Kontum zone of northern Vietnam and the north-south trending Pak Lay-Luang Prabang zone of Laos and eastern Thailand. Zones of ophiolite, calc-alkaline volcanics and strong Late Triassic deformation, they separate the Indosinia and Shan-Thai-Malaya Blocks from the Craton respectively. These findings differ significantly from previous interpretations of a Late Paleozoic consolidation of South-Eastern Asia as well as disputing the existence of a true Pangea.
Tectonics, Paper 3T0394

8199 General (Fault Creep)
INFLUENCE OF SEISMICITY AND RAINFALL ON EPISODIC CREEP ON THE SAN ANDREAS FAULT SYSTEM IN CENTRAL CALIFORNIA
Sandra Schulz (Mail Stop 77, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025), Robert O. Burford and Barbara Mavko
Simple wire-type extensometers (creepmeters), placed across traces of the San Andreas fault system in central California, have produced nearly continuous records of aseismic fault slip (fault creep) for 12 years. The records indicate seasonal and other changes in creep activity that may be responses to variations in local seismicity and rainfall. One frequent type of response is a sudden, episodic movement, or creep event. Onset times of creep events on records from four creepmeters were compared with origin times of local earthquakes and onset times of rain. Seismicity appeared to affect long-term creep rates, but did not consistently trigger creep events. Rainfall produced varying responses on the instruments, but, when compared annually to total creep, number of local magnitude 2+ earthquakes, number of creep events, and total amount of movement in the form of creep events, total rainfall showed no significant linear correlation with any of the variables. The dry part of the annual rainfall cycle appeared to delay onset of creep events. These "delayed" events were consistently larger than events during the rainy season. (Fault creep, rainfall, earthquakes).
J. Geophys. Res., Red, Paper 3B0750